TR 845
.S6
Set 2
12

THE LIBRARY OF CONGRESS

Scanned from the collections of
The Library of Congress

Packard Campus
for Audio Visual Conservation
www.loc.gov/avconservation

Motion Picture and Television Reading Room
www.loc.gov/rr/mopic

Recorded Sound Reference Center
www.loc.gov/rr/record

THE LIBRARY OF CONGRESS

TRANSACTIONS

OF THE

SOCIETY OF MOTION PICTURE ENGINEERS

CONTENTS

Officers 3
Lists of Various Committees 6
Members 8
President's Address 13
Meeting of Board of Governors 16
Report of Educational Committee 18
Report of Advertising Committee 20
Papers Committee Report 21
Report of Committee on Electrical Devices 23
Tentative Report of Optics Committee 25
Motion Picture Nomenclature 34
A Review of Material, Pertaining to Motion Picture Engineering. By R. P. Burrows 39
Lighting for Motion Picture Theatres. By J. L. Stair 52
Discussion of J. L. Stair's Paper 70
Motion Picture Cameras. By Carl Louis Gregory, T. R. P. S. 73
Discussion of Gregory's Paper 82
The Absorption of Light by Toned and Tinted Motion Picture Film. By Loyd A. Jones and C. W. Gibbs 85
Discussion of Paper. By L. A. Jones 101
Condenser Lenses for Theatre Motion Picture Equipment. By Carl E. Egeler 104
Discussion on Mr. Egeler's Paper 114
Address of Mr. F. W. Stratton 124
Continuous Motion Projector of the Taking of Pictures at High Speed. By C. Francis Jenkins 126
Discussion of Mr. Jenkins' Paper 128
Color Photography. By Dr. F. E. Ives 132
Discussion of Dr. Ives' Paper 135
Building a Non-Theatrical Film Library. By L. E. Davidson 139
Discussion of Paper by L. E. Davidson 144
Submarine Photography. By J. E. Williamson and Carl L. Gregory 149
Address by Mr. Henry D. Hubbard, "The Motion Picture of Tomorrow" 159
New Developments in Mazda Lamp Projection. By C. A. B. Halvorson, Jr. 168
Discussion of Paper by C. A. B. Halvorson, Jr. 182

Number Twelve

MEETING OF MAY 9-10-11-12, 1921

WASHINGTON, D. C.

TRANSACTIONS

OF THE

SOCIETY OF MOTION PICTURE ENGINEERS

SEP 3 2 1921
SMITHSONIAN

Number Twelve

MEETING OF MAY 9-10-11-12, 1921

WASHINGTON, D. C.

2d rec't

TR845
.S6
2d ed.
v.2

Copyright, 1921, by
Society of
Motion Picture Engineers
New York, N. Y.

OFFICERS

President

H. A. Campe
Pittsburgh, Pa.

Vice-President

Max Mayer
Brooklyn, N. Y.

Vice-President

R. P. Burrows
Cleveland, O.

Secretary

A. F. Victor
New York City

Treasurer

Will C. Smith
New York City

Past President

C. Francis Jenkins
Washington, D. C.

Board of Governors

The President — The Secretary — The Treasurer
L. C. Porter, Harrison, N. J. — Willard B. Cook, New York
The Past President

EXTRACTS FROM BY-LAWS

Membership in the Society of Motion Picture Engineers stands for unselfish service to the Industry. Applications for membership are by invitation and endorsement. All checks should be made payable to the Society of Motion Picture Engineers.

All receipts are expended directly to promote the objects of the Society and the interests of its members. There are no salaries or emoluments of any kind.

The following are extracts from the By-Laws:

The objects of the Society are: The advancement in the theory and practice of motion-picture engineering and the allied arts and sciences, the standardization of the mechanisms and practices employed therein and the maintenance of a high professional standing among its members.

Qualifications

Active Member—An Active member shall not be less than 25 years of age and shall be:

(a) A motion picture engineer by profession. He shall have been in the practice of his profession for a period of at least three years and shall have taken responsibility for the design, installation or operation of systems or apparatus pertaining to the motion picture industry.

(b) A person regularly employed in motion picture or closely allied work, who by his inventions or proficiency in motion picture science or as an executive of a motion picture enterprise of large scope, has attained a recognized standing in the motion picture art. In the case of such an executive, the applicant must be qualified to take full charge of the broader features of motion picture engineering involved in the work under his direction.

Associate Member—An Associate member shall not be less than 21 years of age and shall be:

A person who is interested in or connected with the study of motion picture technical problems or the application of the same.

Any person of good character may be a member in any or all classes to which he is eligible.

Prospective members shall be proposed in writing by at least one member in good standing, and may be elected only by the unanimous vote of the Board of Governors.

All applications for membership or transfers in class shall be made on blank forms provided for the purpose, and shall be accompanied by the required fee.

Entrance Fees and Dues

The entrance and transfer fees, payable on admission to the Society, or upon transfer, are as follows: Admission to grade of Active member, $35.00; admission to grade of Associate member, $10.00.

The transfer fee from Associate grade is the difference between the admission fee, or $25.00.

The annual dues are as follows: For Active members, $20.00; for Associate members, $10.00.

LISTS OF VARIOUS COMMITTEES—1920-1921

Society of Motion Picture Engineers

Electric Devices Committee

W. F. Little, *Chairman*

R. L. Lee
A. R. Dennington
J. H. Hertner
W. C. Kunzman
Max Mayer
J. S. Speer
E. L. Bragdon
C. A. B. Halvorson
A. D. Cameron
J. R. Manheimer
H. F. O'Brien
P. R. Bassett
W. C. Hubbard

Projection Machines Committee

W. C. Smith, *Chairman*

A. C. Roebuck
W. B. Cook
F. H. Richardson
C. F. Jenkins
E. M. Porter
A. F. Victor
Herman Casler
J. R. Cameron
B. R. Proctor
F. Morrison

Papers Committee

L. C. Porter, *Chairman*

R. P. Burrows
H. C. MacNary
E. L. Bragdon

Safety Committee

A. F. Victor, *Chairman*

J. C. Moulton
G. A. Blair

Auditing Committee

A. D. Cameron, *Chairman*

Frank Rembusch
J. S. Speer

Optics Committee

W. E. Story, Jr., *Chairman*

Hermann Kellner
E. L. Bragdon
R. S. Burnap
L. A. Jones
W. V. D. Kelley
J. C. Kroesen
W. F. Little
F. H. Richardson
H. P. Gage
H. M. R. Glover

Nomenclature Committee

C. F. Jenkins, *Chairman*

Carl Gregory
Max Mayer
H. P. Gage
W. E. Story, Jr.
W. F. Little
Major R. Grierson
H. F. O'Brien

Studios Committee

E. F. Murphy
W. R. Rothacker
W. R. Mott
W. C. Hubbard
M. W. Palmer
H. F. O'Brien
Walter Quinlan

Educational Committee

A. R. Dennington, *Chairman*

F. H. Richardson	E. K. Gillett	C. A. B. Halvorson
G. A. Blair	W. B. Cook	L. E. Davidson
A. F. Victor	J. R. Cameron	C. E. Egeler
C. F. Jenkins	W. F. Braun	Carl Gregory

Publications Committee

W. B. Cook, *Chairman*

E. L. Bragdon	H. C. MacNary	J. C. Kroesen

Advertising Committee

R. P. Burrows, *Chairman*

J. A. Summers	W. C. Kunzman

Membership Committee

A. C. Roebuck, *Chairman*

C. F. Jenkins	W. C. Kunzman	W. C. Hubbard
E. K. Gillett	G. A. Blair	F. H. Richardson
H. F. O'Brien	G. F. Perkins	W. C. Smith
R. L. Lee	H. H. Cudmore	R. Grierson

Cameras and Perforations Committee

W. B. Cook, *Chairman*

Carl Gregory	Carl Akeley	C. F. Jenkins
	A. S. Howell	

Reciprocal Relations

R. P. Burrows, *Chairman*

Hermann Kellner	W. B. Cook

MEMBERS

AKELEY, Carl E.,
Akeley Camera, Inc.,
244-250 West 49th St.,
New York City.

**ALLISON, John W.,
Welanetz Company, Inc.,
Bartholdi Building,
Broadway & 23rd St.,
New York City.

ANDERSON, Carl,
21 Douglaston Road,
Douglaston, L. I.,

BARNES, H. F.,
Edison Lamp Works,
General Electric Co. Div.,
Harrison, N. J.

BASSETT, Preston R.,
Sperry Gyroscope Co.,
Manhattan Bridge Plaza,
Brooklyn, N. Y.,

BATEHOLTZ, C. F.,
General Electric Co.,
Schenectady, N. Y.

BEECHLYN, J. T.,
General Electric Co.,
Lynn, Mass.

BIRKHOLM, Axel V.,
(Assoc.)
Nicholas Power Co.,
90 Gold St., New York City.

BLAIR, George A.,
343 State St.,
Rochester, N. Y.

BLIVEN, Joseph Edward,
(Assoc.)
394 Bank St.,
New London, Conn.

BRAGDON, E. L.,
Motion Picture News, Inc.,
729 7th Ave., New York City.

BRAUN, Wm. T.,
64 East Van Buren St.,
Chicago, Ill.

BROCKET, Paul,
Smithsonian Institute,
Washington, D. C.

BURNAP, Robert S.,
Edison Lamp Works,
Research Laboratories,
Harrison, N. J.

BURROWS, Robert P.,
209 Sloan Bldg.,
823 Prospect Ave.,
Cleveland, Ohio.

CAMERON, A. D.,
General Elec. Co.,
Supply Dept.,
Schenectady, N. Y.

CAMERON, James R.,
Theatre Supply Co.,
124 West 45th St.,
New York City.

CAMPE, H. A.,
5550 Raleigh St.,
Pittsburg, Pa.

**CANDY, Albert M.,
Westinghouse Electric & Mfg. Co.,
Gen. Eng. Dept.,
East Pittsburg, Pa.

CASLER, Herman,
Marvin & Casler Co.,
328 N. Peterboro St.,
Canastota, New York.

CLARKE, Victor H. (Assoc.),
Studio Supervisor,
Famous Players-Lasky Corp.,
6th & Pierce Aves.,
Long Island City, N. Y.

COOK, Willard B.,
Pathescope Co.,
Aeolian Hall, New York City.

CROMELIN, Paul H.,
Inter-Ocean Film Corp.,
218 West 42nd St.,
New York City.

CUDMORE, H. H.,
Argus Enterprises, Inc.,
815 Prospect Ave.,
Cleveland, Ohio.

DAVIDSON, L. E.,
United Projector & Film Co.,
69 West Mohawk St.,
Buffalo, N. Y.

DENNINGTON, A. R.,
Westinghouse Lamp Co.,
Bloomfield, N. J.

DUTTON, H. A. R. (Assoc.),
845 South Wabash Ave.,
Chicago, Ill.

DWYER, Leo. E.,
Dwyer Bros. & Co.,
520 Broadway, Cincinnati, O.

EGELER, C. E.,
National Lamp Works,
Engineering Dept.,
Nela Park, Cleveland, Ohio.

FOX, Wm. Francis,
130 West 46th St.,
New York City.

FREULER, John R.,
615 Linwood Ave.,
Milwaukee, Wisconsin.

GAGE, H. L. (Assoc.),
Allen Theatres, Ltd.,
13 Richmond St., East,
Toronto, Canada.

GAGE, Henry Phelps,
Corning Glass Works,
Corning, N. Y.

GAGE, Otis Amsden (Assoc.)
Corning Glass Works,
Corning, N. Y.

GILBERT, Frank J.,
(Assoc.)
National Cash Register Co.,
Dayton, Ohio.

GILLETT, E. Kendall,
Motion Picture News, Inc.,
729 7th Ave., New York City.

GLOVER, Harry M. R.,
Gundlach - Manhattan Optical Co.,
Rochester, New York.

GORRETTA, Andrew,
Cosmograph Motion Picture Co.,
Morehead, Kentucky.

GREGORY, Carl Louis,
76 Echo Ave., New Rochelle,
New York.

GRIERSON, Major R.,
82 Wardour Street,
London, W. 1, England.

GRIFFIN, Herbert (Assoc.),
Nicholas Power Co.,
90 Gold St., New York City.

HALVORSON, C. A. B.,
General Electric Co.,
West Lynn, Mass.

HASTINGS, R. G.,
Motion Picture Apparatus Co.,
118 West 44th St.,
New York City.

HERTNER, J. H.,
Hertner Electric Co.,
1905 West 114th St.,
Cleveland, Ohio.

HOCHSTETTER, F. W.,
P. O. Box 895, Dayton, Ohio.

HORNSTEIN, J. C. (Assoc.)
729 7th Ave., New York City.

HOWARD, Thomas (Assoc.)
118 Fulton St.,
New York City.

HOWELL, A. S.,
1801 Larchmont Ave.,
Chicago, Illinois.

HUBBARD, Wm. C.,
Cooper Hewitt Electric Co.,
95 River St., Hoboken, N. J.

**IVES, F. E.,
1327 Spruce St.,
Philadelphia, Pa.

JENKINS, C. Francis,
1519 Connecticut Ave.,
Washington, D. C.

JOHNSON, M. Bernays,
Westinghouse Lamp Co.,
Bloomfield, N. J.

JONES, L. A.,
Kodak Park Bldg., No. 3,
Rochester, N. Y.

KELLEY, Wm. V. D.,
Prizma, Inc.,
71 West 23rd St.,
New York City.

KELLNER, Dr. Hermann,
635 St. Paul St.,
Rochester, N. Y.

KESSEL, N.,
Main St. & Linwood Ave.,
Fort Lee, N. J.

**KRAEMER, August E., (Assoc.)
Chief Studio Electrician,
Famous Players-Lasky Corp.,
6th & Pierce Aves.,
Long Island City, N. Y.

KROESEN, J. C.,
Edison Lamp Works,
Harrison, N. J.

KUNZMANN, Wm. C.,
1529 Kenilworth Ave.,
Cleveland, Ohio.

LADD, W. P. (Assoc.),
Perkins Electric Co.,
Phillips Square,
Montreal, Canada.

LAIR, C.,
Pathe Cinema,
30 Rue des Vignerons,
Vincennes, France.

LANG, C. J.,
Lang Mfg. Works,
Olean, New York.

LEE, R. L.,
Delco Light Co.,
Dayton, Ohio.

LEVENTHAL, J. F.,
128 East 45th St.,
New York City.

LITTLE, W. F.,
Electrical Testing Laboratories,
80th St. & East End Ave.,
New York City.

McGINNIS, F. J. (Assoc.),
Speer Carbon Co.,
St. Marys, Pa.

McNABB, J. H.,
1801 Larchmont Ave.,
Chicago, Ill.

**MacNARY, H. C.,
Westinghouse Electric & Mfg. Co.,
165 Broadway,
New York City.

MANHEIMER, J. R.,
E. J. Electrical Installation Co.,
221 West 33rd St.,
New York City.

MARSON, R. D. (Assoc.),
United Theatre Equipment Corp.,
28 Piedmont St.,
Boston, Mass.

MAYER, Mad. (Vice Pres.),
M. J. Wohl & Co., Inc.,
Paynter Ave.,
Long Island City, N. Y.

MORRISON, Francis,
(/o Barr & Stroud, Ltd.,
15 Victoria St.,
London, S. W. 1, England.

MOTT, W. R.,
Union Carbide & Carbon Research Laboratories,
Thompson & Nelson Aves.,
Long Island City, New York.

MOULTON, J. C.,
General Electric Co.,
120 Broadway,
New York City.

MURPHY, E. F.,
Universal Film Mfg. Co.,
Fort Lee, N. J.

NELSON, E. Wm.,
Wilart Instrument Co.,
13 Rose St., New Rochelle,
N. Y.

NELSON, Otto (Assoc.),
National Cash Register Co.,
Dayton, Ohio.

NIXON, Ivan L. (Assoc.),
Bausch & Lomb Optical Co.,
Rochester, New York.

NORRISH, B. E.,
442 Harvard Ave., N. D. G.,
Montreal, Canada.

O'BRIEN, Harold F.,
811 Van Nuys Bldg.,
Los Angeles, Calif.

**OHMER, W. L. (Assoc.),
Recording & Computing Machine,
Dayton, Ohio.

**OTT, H. N.,
Spencer Lens Co.,
Buffalo, N. Y.

**PALMER, M. W.,
Electrical Engineer,
Famous Players-Lasky Corp.,
6th & Pierce Aves.,
Long Island City, N. Y.

PERKINS, E. G. (Assoc.),
704 Dollar Bank Bldg.,
Youngstown, Ohio.

PERKINS, George F.,
497 Phillips Square,
Montreal, Canada.

PORTER, E. M.,
Precisions Machine Co., Inc.,
317 East 34th St.,
New York City.

PORTER, Edwin S.,
Precision Machine Co., Inc.,
317 East 34th St.,
New York City.

PORTER, Lawrence C.,
Edison Lamp Works,
5th & Sussex Sts.,
Harrison, N. J.

**POWRIE, John H.,
Warner Research Laboratory,
Room 1321,
461 Eighth Ave.,
New York City.

PRATCHETT, A. B.,
(Assoc.)
Caribbean Film Co.,
Animas 18, Havana, Cuba.

**PROCTOR, B. R.,
618 West 114th St.,
New York City.

QUINLAN, Walter,
Fox Film Corp.,
55th St. & 10th Ave.,
New York City.

RABELL, Wm. H.,
729 7th Ave., New York City.

REDPATH, Wm.,
156 King St., W.,
Toronto, Canada.

REMBUSCH, Frank,
Rembusch Screen Co.,
Shelbyville, Indiana.

RICHARDS, Thomas T.,
Wagner Electric Mfg. Co.,
6400 Plymouth Ave.,
St. Louis, Mo.

RICHARDSON, Frank H.,
Moving Picture World,
516 5th Ave., New York City.

ROEBUCK, A. C.,
Enterprise Optical Co.,
564 West Randolph St.,
Chicago, Illinois.

**ROGERS, Rowland (Assoc.),
Picture Service Corp.,
51 East 42nd St.,
New York City.

ROGERS, Stephen Carleton,
General Electric Co.,
West Lynn, Mass.

ROHR, C. A. (Assoc.),
General Electric Co.,
120 Broadway,
New York City.

ROSE, S. G.,
Victor Animatograph Co.,
Davenport, Iowa.

ROSSMAN, Earl W.,
1630 St. Nicholas Ave.,
New York City.

ROTHACKER, W. R.,
Rothacker Film Mfg. Co.,
1339 Diversey Parkway,
Chicago, Ill.

**SCHLICKER, Herman C.,
129 Michigan St.,
Milwaukee, Wisconsin.

**SHERMAN, Harry (Assoc.),
Local 306, M. P. M. O.,
101 West 45th St.,
New York City.

SMITH, Will C. (Treas.),
Motion Picture Equip. Corp.,
719 7th Ave., New York City.

SPEER, J. S.,
Speer Carbon Co.,
St. Marys, Pa.

**STATES, Wm. M.,
International Gen. Elec. Co.,
Box 926, Shanghai, China.

STEVENSON, A. R., Jr., (Assoc.),
General Electric Co.,
Power & Mining Engineering Dept.,
Schenectady, N. Y.

STORY, Dr. W. E., Jr.,
General Electric Co.,
Schenectady, N. Y.

SUMMERS, John A.,
Edison Lamp Works,
Harrison, N. J.

TURNER, H. H.,
Gundlach-Manhattan Optical Co.,
Rochester, N. Y.

URBAN, Charles,
71 West 23rd St.,
New York City.

VICTOR, A. F.,
50 West 67th St.,
New York City.

WESCOTT, W. B.,
Technicolor Motion Picture Corp.,
110 Brookline Ave.,
Boston, Mass.

**WHITE, J. Roger,
Graphoscope Co.,
49 Mechanic St.,
Newark, N. J.

WIBLE, Harvey M.,
Westinghouse Electric & Mfg. Co.,
379 Broad St., Newark, N. J.

WILLIAMSON, Colin M.,
Williamson Kinematograph Co., Ltd.,
Litchfield Gardens, Hawthorn Road,
Willesden Green, N. W. 10,
London, England.

WOLLENSACK, Andrew,
Wollensack Optical Co.,
Rochester, N. Y.

ZIEBARTH, C. A.,
1801 Larchmont Ave.,
Chicago, Illinois.

President's Address

Society of Motion Picture Engineers

THIS meeting in Washington and at this Hotel is of historical and sentimental interest to our members. Almost five years ago —on July 24th, 1916—Mr. C. Francis Jenkins called a meeting in this Hotel for the purpose of organizing a Society to work out the details of and to discuss subjects peculiar to the motion picture industry, primarily for the purpose of effecting standardization in the industry. Of the nine men who attended this meeting, five are still Active members; namely, Messrs. Jenkins, Gillett, Brockett, Cromelin and Wescott. This meeting formed the basis for the organization of our Society in New York City on October 2nd and 3rd, 1916, at which the first Officers were elected. That we have made progress, goes without saying. We have kept abreast of the times and the many developments in the motion picture industry will, I am sure, afford ample opportunity for still further progress.

In order to retain the standing which we now have in the industry and in engineering in general, we must be ever active and aggressive. Our aim is to promote successful motion picture engineering. This involves doing—a little better—what some other engineers have already done. To do this, we must each make a careful and systematic study of and become thoroughly familiar with what has already been accomplished in the different phases of the industry and then bend our efforts to do something or to create something that is better.

Although we have made progress in having Committee Reports submitted and excellent papers presented during our semi-annual meetings, yet, I feel that we have failed to accomplish all that for which the Society was formed, respecting standardization. Some standards, previously universally accepted, have been adopted, while others originating in our Society have also been adopted by us. Yet, considering the motion picture industry as a whole, it seems that we have not accomplished as much as we should. Your Board of Governors has realized this condition and from a partial analysis, which has been made, it feels that this condition is due to the lack of interest and co-operation in the various Committees. We have been working on the plan that standardization should originate in the various Committees, but this has not brought the desired results. I trust that some action will be taken at this meeting to stimulate activity, either by the selection of a Standardization Committee, with duties definitely outlined, or by some other plan which you may deem advisable.

Your Board of Governors call to the attention of the newer members, the fact that we have available copies of our previous Transactions. These Transactions contain over 50 Papers by the best authorities on motion picture engineering. The Committee on

Papers and the Publication Committee have prepared a small booklet giving an outline of what our Transactions contain and it is urged that you make a list of those Transactions which you require to make your files complete, and order copies through the Secretary. We shall be glad to furnish you with such copies of this booklet for distribution outside of the Society, as you may think worth while. By this method, we hope to make the Society and its activities more valuable to the industry and at the same time increase our finances. The price charged for copies of our Proceedings does not cover the cost of printing and binding. Our Proceedings contain data and information which cannot be obtained through any other channels whatsoever.

With your permission, I should like to say a few words regarding membership. It is true, we have been enjoying a steady and healthy growth, yet we must look to the future for expansion commensurate with the importance of the industry. At the formation of the Society in 1916, we had a total of 23 members, while today, not including those names which were acted upon by the Board of Governors yesterday, our membership totals 105, of which 91 are Active and 14 are Associate members. There are many phases of motion picture engineering and there is a large number of men who are active in the industry's engineering interest. Where men are of the proper calibre, we should use our efforts to have them affiliate with us. Bear this in mind, however, we are building up an organization for the future and we should therefore be critical in our investigations before we admit new members. What we are after is men who are energetic and who will contribute to our activities. Our Society was not formed to create motion picture engineers. We desire only such members as will present, before the Society, new ideas and problems for discussion. Application blanks can be obtained from the Secretary or chairman of the Membership Committee. Applicants should fill in the blanks, giving details of their activities.

I call your particular attention to the plan which we are trying out at this meeting in connection with the presentation of Papers. Abstracts only will be read by the authors, unless the Paper is very short or cannot readily be abstracted. Advance copies of papers are available, and although certain members have been especially asked to discuss these Papers, it should be distinctly understood that all those present are expected to enter into the discussion. In this way, we shall be able to obtain the greatest benefit possible from these Papers. Stenographic notes will be made of the discussions and will become a part of our printed Transactions. Quite often, the discussions are as vitally important as the Papers themselves. The results we obtain at this meeting will serve as a guide respecting the value and scope of future discussions.

It would not be amiss to mention, at this time, the activities of your Officers. Your Board of Governors have met three times since the last regular meeting for the purpose of transacting the business of the Society, and to formulate plans for the future. These meetings have necessitated considerable correspondence. All this work

has been carried on without expense to the Society. I have asked our Treasurer to give you a short analysis of how your funds have been handled. The work of the Committee on Arrangements and the Committee on Papers is evidenced in the program which has been scheduled for the next four days. The duties of the Committee on Papers involve more exacting work than any branch of our Society. In preparing the program, it is always necessary to make quite a number of tentative outlines, which are changed many times before the final set-up is made. This Committee, then, has to get the manuscript in an approved state for presentation. Before Papers are finally printed, as part of the Transactions, they must be proof-read. With stenographic records of discussions, the work of this Committee will be enlarged. It costs considerable to get out the Transactions which are distributed to all members without charge. We endeavor to cover some of this expense by making use of part of the space in the Transactions for advertising purposes. From the report of the Committee on Advertising and the results obtained so far in selling space for this year, the opportunity of advertising in our Transactions is evidently appreciated. Each firm represented in the Society should use our Transactions as an advertising medium and we shall also be glad to consider space for concerns not represented in the Society. I would like to call your attention to the work of the various Committees, as well as to the individual efforts which have been extended, but as these activities will be covered by later reports, I shall not take up any more time as I know you desire to get started on the excellent program which has been prepared.

I should like, however, at this time to extend to the Officers, to the various Committees and to the members, my very sincere appreciation of the helpful co-operation which has been extended. Such co-operative spirit is the very basis of the existence and continuous success of our Society.

H. A. Campe,
President.

Washington, D. C.,
May 9th, 1921.

MEETING OF THE BOARD OF GOVERNORS

of the

Society of Motion Picture Engineers

HOTEL RALEIGH

WASHINGTON, D. C.

SPRING CONVENTION

SUNDAY, MAY 8, 1921, at Eight P. M.

Members Present

H. A. CAMPE
C. FRANCIS JENKINS
A. F. VICTOR
W. C. SMITH
HERMANN KELLNER
L. C. PORTER
WILLARD B. COOK

Guests

MAX MAYER
WILLIAM V. D. KELLEY

The following motion was made and seconded:

> THAT the Board of Governors instruct Vice-President, Mr. Burrows, to make a tentative analysis of the duties of the various committees and make a report to the Board of Governors for further action.

This motion was unanimously carried.

A motion was made, seconded and carried:

> THAT a standardization committee of three be appointed by the Board of Governors; that a careful study of the qualities of these men be made from a list of prospective appointees, submitted by each member of the Board of Governors; said list to be obtained by the Secretary and presented at the next meeting of the Board of Governors for action; the duties of this committee to be outlined in the tentative list of duties to be outlined by Mr. Burrows.

A motion was made, seconded and carried:

> THAT the Secretary be instructed to place a sticker in all synopsis booklets sent out to libraries, members and others, giving his address and the prices of the different Transactions.

Upon motion made, seconded and carried, it was:

> RESOLVED, that all members desiring back copies of Transactions must pay for same at regular rates.

An offer made by the Secretary to store the Transactions at his office in the Bush Terminal Sales Building in New York City was accepted.

The Secretary was authorized to purchase a cabinet or case to hold the Society cuts and other items used in printing the Transactions.

Extracts from the Minutes of the Board of Governors Meeting Held on November 29, 1920:

After considerable discussion it was decided to abolish the Sustaining Membership classification.

The following men were appointed a committee to investigate laboratory conditions in connection with the standardization of machinery employed in the laboratories, with special reference to printing machines:

A. F. Victor, *Chairman*
Max Mayer
W. B. Cook

A motion was made, seconded and carried, that in the future the nominating committee be comprised of the Board of Governors.

Extracts from the Minutes of the Board of Governors Meeting Held on January 24, 1921:

A motion was made, seconded and carried, that a Committee on Standards should be appointed at the next meeting.

A motion was made, seconded and carried, that negotiations be carried on with the American Engineering Standards Committee, in connection with having them recognize the standards adopted by the Society of Motion Picture Engineers, by Mr. Porter.

A motion was made, seconded and carried, that the secretary be instructed to send a letter to all of the libraries in the United States, suggesting that the Society's Transactions be put into the libraries.

It was further moved and seconded, that the secretary be instructed to write to any other organizations or societies, which might be interested in securing the literature of the Society.

Report of Educational Committee

Society of Motion Picture Engineers

Washington Meeting, May 9-12, 1921

THE matter which was before the committee was the advisability of the Society of Motion Picture Engineers becoming interested in any way in a correspondence course for projectionists.

A survey was made of the courses of established correspondence schools and revealed that there was at the present time no course available or being seriously contemplated. The International Correspondence School of Scranton reported that they did not care to undertake the development of a course of this kind as it would be necessary to do considerable advertising in order to build up a demand, while there were other courses for which a demand existed. In support of this statement the following report was given of the number of inquiries received through the mails for a course for projectionists:

During the months of April, May and June, 1920, there were only three calls for a course such as we have under consideration. A record was kept for a year or more and showed only an occasional call for a study course on motion picture operating. This indicates that while the projectionist may be in need of the help of a correspondence course he does not voluntarily approach such institutions as the International Correspondence School with a request for a course.

The American School of Correspondence has had a course in motion picture operating which they call by a rather difficult name—"Motography." This course has not been offered in the last two or three years and is very much out of date, being copyrighted in 1911. An examination of the material in this course shows that it is entirely unsuited to the training of projectionists in the art of producing better results on the screen or giving better care to the equipment and material over which they have charge.

In order to get an expression of opinion of the members of the Educational Committee as to our policy the following questionnaire was sent out:

1. Should the Society of Motion Picture Engineers find out if the American School of Correspondence is willing to sponsor a study course for projectionists?

2. Should the Society of Motion Picture Engineers volunteer its services in an advisory capacity in the preparation of this course?

3. If such assistance is proffered by the Society of Motion Picture Engineers should the American School of Correspondence give a percentage of the proceeds from the sale of the course to the funds of the Society?

4. Do you think the members of the Society of Motion

Picture Engineers representing various industries are willing to supply the necessary information to the Correspondence School?

Replies to this questionnaire were received from five members of the twelve comprising the committee. Of the replies received three were in favor of taking this matter up with some institution such as the American School of Correspondence or other reputable correspondence school; one reply was in the negative and one was non-committal.

To the second question the replies indicated three in favor of the Society volunteering its services for supplying the material, while two expressed opposition to action of this kind.

On the matter of remuneration from the correspondence school to the Society for the course the replies showed three negatives, or opposed to such remuneration, while two were in favor of the plan.

Three of the replies expressed an opinion that individual members of the Society would undoubtedly be willing to supply material for such a course; one reply was in the negative and one reply pointed out the fact that this would be a matter which could be answered only by the individuals.

A letter was written to Mr. O. C. Miller, Director of Extension Work of the American School of Correspondence, mentioning the fact that the question of a correspondence course was under consideration by the Society of Motion Picture Engineers. A reply was received from Mr. Miller from which I quote the following:

"Frankly, we would not be interested in publishing such a course unless the Society saw fit to guarantee the sale of a given number of courses, the reason being that the field is rather limited and therefore would be difficult to reach those actually interested. However, if the Society were back of it and would automatically handle the registration of members our objection would be largely over-ruled.

When you have finally decided the issue let's go over the ground carefully.

There is one thing certain—If members of your Society need a thorough course of instruction the Society or someone recommended by the Society is going to prepare the necessary instructions."

In summarizing the entire situation as it exists the following points are presented for the consideration of the Society:

Of the two well-known correspondence schools neither one is interested in assuming the responsibility of developing a course for projectionists, as they feel that the demand is limited.

If a correspondence course were developed by the Society itself it would necessitate a considerable expenditure, as was outlined in previous reports.

These two methods seem to be the only feasible ones. If it were possible to secure closer cooperation of the members of the Society a study course might possibly be developed by the organization itself. However, as the members of the Society

must travel long distances in order to get together for committee meetings most of the work must be done by correspondence and it would be extremely difficult to build up a satisfactory study course unless some individual could give his undivided time to the subject.

Under the circumstances, I would suggest that the matter of a study course for projectionists be laid on the table to be taken up at a later date when the growth of the Society and the financial condition would warrant further consideration of this matter.

Messrs. F. H. Richardson, G. A. Blair, C. F. Jenkins, E. K. Gillett, W. B. Cook, J. R. Cameron, W. T. Braun, C. A. B. Halverson, L. E. Davidson, C. E. Egeler, Carl Gregory

A. R. Dennington,
Chairman Educational Committee.

Report of the Advertising Committee

LAST year the Transactions carried fourteen full pages of advertising, three half pages and two quarter pages making a total value of $855.00. So far this year your committee has obtained nine full pages of advertising, two full pages of preferred space and two half pages of advertising, making a total value of $690.00.

Four companies advertising in 1920 Transaction have decided not to advertise in 1921. Two advertisers of 1920 we have not as yet heard from. It has been difficult to obtain advertisers outside of our own organization and your committee would appreciate suggestions as to the best way of obtaining such advertising.

Your committee circularized the membership on two occasions and has been considerably disappointed at the response obtained. There is still an opportunity to take advantage of the valuable space offered for advertising in our Transactions. Your committee would be pleased to receive subscriptions at any time during the convention.

Respectfully submitted,

ADVERTISING COMMITTEE
Robt. P. Burrows, *Chairman*
W. C. Kunzman
J. A. Summers

Papers Committee Report

SPRING CONVENTION, 1921

Society of Motion Picture Engineers

Mr. Chairman and Gentlemen:

Your Papers Committee has worked very hard during the past six months. For the first four months, we had a meeting at least once a month, and for the past two months, we have had a meeting every two weeks.

We are conceited enough to believe that we are the back bone of the Society and, like all back bones, we have an end, which is often the recipient of kicks. However, sufficient kicking develops callousness, and we have carried on to the best of our abilities.

This year, the work of your committee was divided among the members, each man being assigned specific duties. The chairman expresses his appreciation of the manner in which each member of the committee has carried out his part of the work.

We have tried to cooperate closely with the officers and other committees of the Society, particularly the committees on publications, advertising and utilities.

We have experienced no difficulties in securing *promises* of excellent papers for the convention. In fact, we have had to turn down some of the offers in order to carry out the wish of the membership to have more free time at the convention.

We still experience great difficulty in securing the texts of promised papers in sufficient time to have advance copies prepared; the convention program printed, etc. We beseech your cooperation in improving this condition.

Advance galley proofs were printed of the papers which were received previous to the convention. Each author was asked to name those whom he considered could add valuable discussion to this paper. In addition to that, the Papers Committee made up a list of men who, in its opinion, were especially fitted to discuss the various papers. Letters were sent to these men asking them to discuss the papers, and if unable to attend the convention, to send in a written discussion. Definite instructions were given to have advance galley proofs sent to that list of men. However, due to the man on the Papers Committee, who was following that work, dropping his connection with the motion picture industry shortly before the convention, there was a slip-up somewhere, and the galley proofs did not go out. We shall so safeguard things for the next convention that there can be no slip-up.

This year we have a stenographer to record the discussions. It is our suggestion that discussions be limited to four minutes. Stenographic records of discussions cost real money, and while we want to get as much meat as possible in our Transactions, we must conserve our finances.

Each year your Papers Committee tries to do some permanent thing of lasting benefit to the Society, in addition to securing and editing papers.

In the absence of a Standardization Committee, this year we undertook to have our standards recognized by the American Engineering Standards Committee. The letter which I read to you yesterday indicates good progress along that line; progress which we hope can be carried to a successful conclusion by the new Standards Committee that is to be appointed.

We should like to know if the types of papers we have been securing are what the members of the Society desire? It is *your* Society, and we want to produce what *you* want. To do this, *you* must help. Let us know of interesting work that is going on. Suggest to us subjects for papers, and possible authors, and do it now.

We should greatly appreciate it if, between now and the time for tomorrow's sessions, you would write out suggestions for the Fall convention. We would also ask the presiding officer to set aside a few minutes tomorrow for the receipt and discussion of suggestions for the Fall convention.

Our motto is, to find out what our job is, do it to the best of our ability, and then do all we can to help the other fellow do his job.

Gentlemen, we thank you.

(Signed) L. C. Porter (*Chairman*)
E. L. Bragdon
R. P. Burrows
H. C. MacNary

Report of Committee on Electrical Devices

Society of Motion Picture Engineers

YOUR Committee wishes to report that its field of activity has been very much limited by reason of other Committees already functioning. Many communications have been sent out and every effort has been made to collect data on electrical developments during the past year with very little success. Most of the developments antedate the beginning of the past year and the only developments which the Committee has found feasible to describe are:

(a) Arc controls,
(b) Generating equipment.

The Committee has appealed to the membership for information and the following is a collection of the data secured.

Arc Controls

Arc controls may be listed in three classes: Double motored, single motored, and mechanical.

Double Motored

This type consists of two similar motors connected through differential gearing, the central gear of the train being connected to the arc feed handle. One of the motors is connected across the line and the other across the arc terminals. The proper carbon setting is selected and the speeds of the two motors made identical by a rheostat in series with the one placed across the line. Once this adjustment has been made there will be no movement of the carbons as long as the voltage across the arc gap remains unchanged. When this voltage does change, the speed ratio of the differential will cause a movement of the arc feed shaft and the arc gap will be altered either one way or the other until normal conditions have been restored.

The double motored type makes it possible to have the striking of the arc carried out automatically, without attention on the part of the projectionist beyond the throwing of the switch. The double motored arc control is typified commercially in the Simplex.

Single Motored

In the case of the Peerless, the device consists of a make and break mechanism connected across the arc terminals which, in turn, starts and stops the motor driving the arc feed shaft. A solenoid is connected in series with the arc through a suitable rheostat. The armature is held away from the contact points by the magnetic force of the solenoid but when the current through the solenoid decreases due to the increase in arc length, and consequently the arc voltage, the tension of the spring overcomes the magnetic motive force and the armature is pulled over against a contact point which establishes the motor circuit. The gearing between motor and arc feed shaft is in the ratio of about 800 to 1 so that a considerable number of revolutions of the motor are required to revolve the feed shaft a sufficient number of times. As soon as the current across the arc increases to the correct amount, the tension of the spring is overcome and the

motor circuit is broken. This device can be used only on direct current installations.

Still another single motor controller is the Speedco. The motor used with this controller is shunt-wound, the fields being connected across the incoming line while the armature is connected across the arc terminals. A centrifugal clutch between the motor and the feed mechanism allows the motor to run free until such time as the arc voltage becomes too high. When the arc voltage rises to too high a value, the centrifugal clutch operates, thereby allowing the motor to drive the arc feed mechanism directly. As soon as the arc has been shortened enough to reduce the arc voltage to the proper value, the motor speed, having decreased, the centrifugal clutch disengages and no further feeding takes place.

The Mechanical Type

The action of the mechanical type of arc controller differs from that of the other makes by the fact that its operation is in nowise affected or controlled by the variations in current or voltage at the arc. The mechanical control is usually connected to the projector motor in some way so that whenever the motor is in operation, the carbons are fed together at a continuous rate by means of a flexible shaft extending from the motor attachment to the arc feed handle. Once adjusted this device will continue to operate at the same rate as long as the motor turns. The Tepico arc feed is of this type.

GENERATING EQUIPMENT

Two different types of apparatus have been developed for obtaining direct current for use with arc projectors, namely, the constant voltage type and the constant current type. The constant voltage generator is substantially the same type as that used in power plants, namely compound wound machines in which the series winding assists the shunt field. The Westinghouse equipment is an example of this type. This type of generator permits the use of several projectors or spot lights at the same time.

Several types of constant current generators are on the market at the present time. In one case regulation is produced with a generator similar to the constant voltage machine with the exception that the series field is connected in opposition to the shunt winding. The Compensarc manufactured by the General Electric Company is an example of this type.

A similar performance is obtained in another way, namely, by shifting the brushes so that the armature reactions demagnetize the shunt fields. The Transverter is an example of this type. This type of device permits of the starting up and warming of a second arc and the dissolving of one picture into another without appreciable fluctuations.

The new Mazda C lamp and electrical control apparatus are described in Mr. Halvorson's paper and are therefore not treated of here.

W. F. Little, *Chairman.*

April 30th, 1921.

Tentative Report of Optics Committee

to

Society of Motion Picture Engineers—May, 1921

I. Physiology of Color

AT the last two meetings of the Society, the Optics Committee has submitted a report on the effect on the audience of a uniformly colored light for motion picture projection.

The first tests indicated that when the motion picture film itself was tinted, if the color was not deep, there was no appreciable decrease in brightness for yellows and greens, and that clearness and contrast were in general noticeably greater in the tinted film than in the untinted one.

In the second test, instead of the film being tinted, a tinted screen was held in front of the objective to produce the colored picture, while neutral screens were used to modify the black and white. This arrangement permitted the previous determination by means of a flicker photometer, of the proportion of white light passed by each tinted screen, and so of the relative amounts of light in the tinted and untinted pictures. In the opinion of the judges there was a marked tendency to consider the yellows as not so bright as their photometered value would lead us to expect. In other words, the ratio of brightness on the screen between the yellow tints and the white was less than the ratio measured by a flicker photometer. The reverse was found to be true with blue—violet, and the other colors give ratios that agree roughly with their position in the spectrum between these two extremes. Contrast and clearness invariably followed brightness.

It is hard to see why clearness and contrast should not rise and fall together, since in monochrome clearness exists only through contrast of brightness. As long as the brightness is within the comfortable range of the eye, the greater the contrast across any line the more sharply will that line be defined. Both tests substantiate this.

It might be noted in passing, however, that when any color consists of a mixture of two differing greatly in wave length, a distinct difficulty is experienced in focusing the eye on the picture. Purple, consisting of red and blue, is an example of such a color. It is hard to say whether this difficulty seems to effect clearness or contrast most. Of course this same reasoning will mean that any monochromatic picture will seem of greater clearness and contrast than a white picture or any other combination of colors. That the tests did not indicate this is probably due to two factors. First, that sharpness of line would tend to make the light parts seem lighter and so increase the general apparent brightness: that is, that brightness and clearness are mutually helpful. And the second, that the detail in projection is not sufficient to make this difficulty of focusing more than one color on the retina simultaneously, apparent, except in extreme cases, such as the purple noted above.

It would seem, too, that lights of different colors and the same brightness should give the same contrast when projecting a neutral picture, unless there were appreciably more scattering by the silver particles for one wave length than for another. In this case, however, we might expect the silver to scatter blue light more than red, and so the shadows in the blue picture would seem darker. Unless these shadows were quite black, we should then have greater contrast with blue than red light. This is contrary to the findings at the first test, but is in accordance with the second test. Accordingly it would seem fair to consider the increase of contrast at the first test to be due to some selective action of the dye on the film, probably a concentration around the silver particles in the shadow. This may be a matter for special investigation, but has probably already been thoroughly tested. If we neglect the first test on these grounds then and abide by the result of the second test, reasonable as it seems, we may consider the whole problem as one of apparent brightness simply.

Now when we speak of one color looking brighter than another, we understand, of course, that some characteristic of the two beams is equal. That is, the two beams are of equal energy, or give equal value of intensity on a flicker photometer, or when viewed in some particular way, or when measured directly by a photographic plate, or in any number of different ways. In general, the lights that prove equal in one of these ways will not match in any of the others. Accordingly when we try to compare different colors of so-called equal brightness on the screen, we are really comparing the conditions of actual use in projection with the test by which the two colors were declared of equal brightness. The diminished or augmented brightness of the observed screens in our second test under or over the fraction transmitted, as measured by flicker photometer, determines then simply the adequacy of the flicker photometer for measuring screen illumination, and if the two systems do not check it means that the flicker photometer cannot be used as a measure of the relative brightness of different colors in projection work.

Since the flicker photometer measurements were made with a gas-filled Mazda lamp as light source and an arc was used to project the picture on the screen, we should expect a slightly greater proportion of the photometer light to pass the yellow screen than of the projector light. In other words, the yellows should look darker on the screen than in the photometer. This may then account for part of the low brilliancy of the yellow, and, by the same reasoning, the high brilliancy of the blue violet; but if this were all, the reds too would give lower values on the screen than we should expect from the photometered readings. This is not found to be the case. It would seem then that the difference in the method of viewing causes a difference in the apparent brightness as measured by the flicker photometer and the motion picture screen.

The great plausibility given flicker photometer readings is their reproducibility. Of course, if there is no definite opinion among the audience as to which color is the brighter, then and only then should

we be justified in resorting to the flicker photometer; but in that case the relative brightness is of no importance in practical projection. Accordingly the only interest in the determination is, not what color looks the brightest on the screen, but rather what other test can we use that will give the same brightness comparison for different colors. The ease of the direct comparison would seem to make the development of any other test but a waste of time.

The above reasoning, if correct, forces us to the conclusion that, if we accept the result of the second test, reasonable as it seems (that clearness and contrast follow brightness) further determinations of the physiological effect of color on the screen are without significance to the art of projection. If this conclusion is justified, then, of course, further tests by our Committee are useless. Unless then the society determines otherwise, the Optics Committee will not proceed further along this line at present.

II. Psychology of Color

When the society directed the Optics Committee to report on the effect of color of motion picture screens the committee understood this to mean the physiological effect of the color. Recently it has developed that some of the members had in mind the psychological effect of color as well.

It would seem like a tremendous undertaking to obtain any information along this line by experiment an undertaking far beyond the province of the Optics Committee. The Committee has thought however that a search in the literature of color might reveal something of interest to the motion picture industry. The remainder of this report is the result of such a search. No attempt has been made to draw any distinction between the psycho-physiological and the purely psychological effect as the border line is so vague.

We ordinarily use the word "color" quite loosely in the sense of one of the characteristics of an object or of a light. Strictly speaking, color is a sensation and does not exist apart from the observer. We have spoken of ultra-violet and infra-red light to such an extent that we have come to regard even them as "colors," though having no more visual significance than the longer electromagnetic waves. Through the whole series of wave lengths from wireless waves to X-rays, we have certain sections causing responses in certain instruments, from the receiving antenna, through the bolometer, the eye and the photographic plate, to the fluorescent screen. Color is properly applied only to that part of the series to which the eye responds.

The sensation of color we receive (i. e., "the color we see") when looking at an object depends on two things. Obviously it depends on the distribution through the spectrum of the energy that enters our eye from the object. This distribution is the cause of the color sensation. This energy, if the object be lighted from without, depends on two things—on the group of wave lengths falling upon the object and upon the relative amounts of light of different wave lengths that are reflected, in the case of a body lighted from the front, or transmitted, if the body be lighted from behind. This cause

of color is a purely physical stimulus capable of measurement and reproduction as accurately as may be required. The effect on the observer of this stimulus, and so the color he sees, depends not only upon this stimulus but also upon the way in which the eye transmits it to the brain and even upon the brain's condition. That the interpretation of the physical stimulus is effected to a great degree by previous and existing conditions is a matter of common observation. Ordinarily the moon looks pale yellow. If, however, we look steadily at a red fire for a few minutes and then glance at the moon, it will seem quite green. This is but an example of a well-known characteristic of vision.

To one emerging suddenly from a dark room ordinary daylight is dazzling to such a degree as to deprive one temporarily of the entire use of his eyes. After a few minutes the eye "adapts" itself to the new condition—that is, becomes less sensitive. On the contrary, when entering a darkened room from daylight many objects can at first not be seen which after a time become easily visible. Thus we see that the apparent brightness of an object depends not only upon the energy coming from it, but on the "adaptation level" of the eye determined by the light which has been falling upon it.

The Young-Helmholtz theory of color vision involved the supposition in the retina of three sets of cells, each responding to light of all the visible waves lengths, but one set responding most strongly to approximately red light, one to green and one to blue. This means that when the first stimulates the brain strongly and the other two but weakly, we get a sensation we call "red." If now for some reason, such as prolonged observation of "red" light, the "red" set of cells becomes less sensitive than the others, a light that under normal conditions would cause an equal stimulus to be sent to the brain from each set of cells, and would so produce the sensation of white, will now cause a stimulus that is weaker in red than in blue or green and we get a sensation of blue-green. Nor, of course, does this weakening of the red, effect the judgment of neutral tints alone, but every object, whatever its color, will be weaker in red than it would be to the normally adapted eye and will accordingly be bluer and greener. In fact, if we look at even a monochromatic light for a long time those cells most strongly affected will become less sensitive than the others and accordingly the color becomes more and more neutral. Of course the point of total neutrality is never reached. The color is simply not as saturated.

This adaptability of the eye has some interesting consequences. If a bright object be viewed for an instant and then the eyes be closed, a bright "after-image" of the object will be seen against the dark background of the red. The brightness of this "positive" image rapidly decays until it is even darker (i. e., "negative" after-image) than the field, if this be slightly illuminated by light falling on the outside of the eyelid. If the original object was white, the positive images in their decay pass through blue-green, indigo, violet-pink, dark orange, etc. If the object was not white, the positive

after-image will be roughly the complementary color. Helmholtz explained this phenomenon as due to retinal fatigue. These after-images are of considerable importance in motion picture projection. They probably account for the increase in flicker observed upon looking rapidly from one part of a picture to another, and for the shock experienced when an entirely different scene is suddenly thrown on the screen.

To perceive different colors from the same physical stimulus, it is not necessary to have different adaptation levels at the beginning. In general, the color of any object is changed by bringing within the field of view an object of any other color, and this change will be in the direction toward emphasizing their differences. For example: if an area normally orange is introduced into a field normally purple, the orange consisting of red and green, will become greener and the purple being red and blue, will become bluer. In short, color depends on environment as well as adaptation level. Perhaps these two subjective causes of color are of most interest to the motion picture producer, since these are the two over which he has most control.

There are other factors entering, such, for example, as the size of the object viewed and its distance; the type to which the observer belongs, i. e., whether he is color-blind, etc., and the faculty common to the great majority of mankind to see what they expect or wish to see if the least excuse be furnished. A striking example of this latter habit is the seeing of snow as white under any but the most abnormal conditions. Of course snow on a clear day is generally not white at all but yellow in the sun and blue in the shade. This the artist sees. The average man knows that snow is white so it looks white to him unless the color becomes so deep as actually to force recognition, against his better judgment as it were. With the visual type of the audience the producer has nothing to do—he can simply plan for the normal. How far the wish for and expectation of a color effect can be stimulated and then satisfied it is impossible to say. It may, however, be interesting to recall the complaints so common when motion pictures were first introduced because so much was lost by the lack of colors, and how that general desire for colored motion pictures seems to have dwindled with the habit of seeing monochromes—and this in spite of the very beautiful work of some of the color processes.

We see then we can only bring color into the observer's immediate consciousness by change of color or by color contrast. This means to us, of course, that if a green picture is thrown on the screen it will soon become less green unless it is alternated with some other color, or unless we have in its neighborhoods light of a different color.

We are, however, not interested only in those lights of the effects of which we are conscious. Are there any subconscious results of light of different parts of the spectrum which we may use?

Scientific data of a positive kind seems to be scarce if not entirely lacking. All the evidence that has been reviewed seems to

show that the physiological functions are uninfluenced to any marked degree by color, even in fact by combinations of color. Snowden (1) had the walls of one ward in a hospital painted in different colors, each room with a different single color or combination, and made a series of tests to determine whether patients recovered more rapidly under one color than another. If, for example, red were stimulating, we might expect the patients living in the red rooms to recover from ailments purely physical more rapidly than those under the quieter tones. No such effect was observed, however, though some colors seemed to effect certain patients psychologically. These experiments are mentioned to show the kind of work done along this line.

Pressey (2) tried rather an elaborate series of experiments on response under illumination of different colors. His tests included tapping and pressure tests, tests on the pleasure of touch, on multiplication speed, on association of words and continuous choice reaction. None of these tests showed a marked difference under different colors of the same intensity but there was a noticeable difference for different intensities. This would seem to refute the contention so often advanced that red is a stimulating and blue a soothing color. In fact no evidence has been found to show any difference between color in their *primary* physiological effects.

Turning now to color preference, we are confronted with such a variety from any large group of individuals that it seems almost impossible to find any general preference either natural or associative.

Ellis (3) finds savages delight especially in red and almost as much so in yellow; that young children show a preference for yellow—possibly because its brightness attracts their attention—but that later boys prefer blue and violet, and girls red. That among adults yellow is the least popular of colors—but 2% of men and 5% of women preferring it to others. On the other hand, in China yellow ranks with red and green as the most popular colors, and in Maylasia second only to white. The classic world affected yellow as a symbol of pomp and magnificence and it was perhaps for this reason that the early Christian church put the taboo on yellow, till it came to signify inconstancy, cowardice and treachery. Instead of representing the power and brilliancy of pagan courts it now represents a jaundiced skin. So can fashion change the taste of man!

Another color that association seems to have given perhaps an unnatural significance is green. In spite of its extreme commonness often in the most beautiful things of nature, green has gathered a disagreeable group of associations.

It is of interest to notice how many of the colors have been intimately connected with the visible evidence of human abnormality, as perhaps is to be expected since colors others than red in its various tints and shades denote unnatural and so uncomfortable conditions. We say, yellow with fever; green with sea-sickness, or envy; blue with cold, or despondency; purple with rage; crimson with embarrassment and scarlet with shame; so that even red, in excess as it were, has an uncomfortable association. To yellow and green alone,

however, does this disagreebleness seem to cling in other connections.

It is not, however, these associative characteristics that determine color preference with the majority of people, but rather conformation to usage. Custom has established certain colors as appropriate to certain things and this to such an extent that it is almost impossible for the individual to free himself from its prejudices. Pink may be used for a baby's sweater, but not for man's cravat. We may not paint a house blue or purple, but yellow and green houses are quite common in spite of the fact that far more people "prefer" blue or purple. These apparently unreasonable rules can be carried on as far as one wishes. The appropriateness of the color on the screen is determined by the subject alone. Where the great part of the subjects before the camera are of one color, such as in pictures of the open sea, or of trees or fields, the screen picture may be colored very appropriately. In general, however, the coloring that suits one subject will be quite unsuitable for another. Of course some things, such as clothes, are recognized as being susceptible of any color.

Apart from individual preference based on association, there seems to be a natural attraction toward red and yellow and a slight acquired sentiment claimed against yellow and green, though from the quantities of yellow and green with which we surround ourselves, it would seem doubtful whether it were not the words yellow and green which we dislike rather than the colors themselves.

It might be noted in passing that some few individuals have an objection to certain colors so strong as to amount to hysteria, but this is a pathological condition which may arise from any stimulus whatever and is not a characteristic of color alone.

On that most interesting subject, the factors that determine the pleasure derived by color combinations, but little has been found, and that little representing such widely divergent views that nothing resembling a consensus of opinion can be said to have been discovered. As far as can be found, there is no definite rule that can be applied to colors to predetermine their harmony. That rules can be laid down for sound vibrations that must be followed if harmony is to result, illustrates one difference between the ear and the eye. The ear is but one scale, responding each part to the proper sound vibration, and these parts interfering disagreeably with each other only under certain definite and, we may say, simple conditions. The eye on the other hand, is a combination of three or more separate and yet, in some way interrelated, sets of nerves, each responding to all wave lengths, but each with a different tuning and each with a different speed in growth and decay of response and of different recuperative powers. Up to the present we must throw the whole burden of harmony on that much overworked sense "good taste" and must be guided by that instinct, our own or anothers, which must always take the place of reason in those questions too complicated for formulated rules.

It would almost seem that the grouping of colors was successful or not, according as it threw the proper emphasis in the proper place.

Colors we regard as highly desirable for a sunset seem to clash when confined within the limits of a vest, even of the most ample. No amount of emphasis can spoil for us a sunset sky—the very emphasis in fact fills us with an awe we call pleasure in the riot of color. The vest, on the other hand, if too emphatic, seems to fill the room to the exclusion of other things perhaps more important, just as does a heavy gold chain. A large black and white check suit, though without color, gives us exactly the same feeling of discomfort as we experience from what we call clashing color. It is not the colors that in themselves clash, but it is rather that the attention attracted by the colors is of an undue amount. A man may turn out to a cricket match in the most gorgeous of blazers because he is of importance as a figure simply. On the lecture platform such a combination of hues would distract the attention from the subject under discussion and so would seem jarring. This same consideration of emphasis leads the artist to give to his work a particular "tone" perhaps to harmonize with the principle part of his subject, and to paint as it were, through a tinted glass, in order to soften his emphasis and so prevent near another often changes its color to a color we regard as unnatural and so as disagreeable. This is perhaps most strongly felt with respect to people. We say certain colors are "unbecoming" to the jarring of too heavy contrast.

Of course, bringing one object near another often changes its color to a color we regard as unnatural and so as disagreeable. This is perhaps most strongly felt with respect to people. We say certain colors are "unbecoming" to certain people—meaning that they emphasize colors in their skin which we are not in the habit of associating with the normal skin. This, of course, is but another case of association of a single color rather than a misplaced emphasis. In short, by these two things, association and emphasis, does all our feeling for color seem to be caused.

No consideration of color in connection with motion picture projection, however brief, could be closed without at least a mention of the "color organ." Musical chords, even the most complicated, can be resolved into definite individual notes, whereas a single color can in general be built up in more than one way. We must not necessarily expect then to find a one to one relation between these two systems of perception. However music can appeal emotionally by its rhythm alone, and since saturation at least, is capable of rhythm we have the foundation of an emotional vehicle upon which sometime as complicated a structure may be raised for our enjoyment as has been built up on the tom tom "music" of the bushmen.

The above discussion of color is necessarily so brief that it cannot attempt to describe the uses to which color can be put in projection, and will accomplish its whole object if it but creates enough interest in the subject to lead to suggestion from the Society for possible uses of color in motion picture work. A careful study of the references given will repay anyone. Color and color psychology is at present so dependent on personal opinion and the standards and nomenclature are so vague, that a vast number of articles have

appeared in the current magazines quite dogmatic in form but which give no evidence whatever for the truth of statements upon which the entire argument rests. The committee would like to suggest that all such statements as to the "stimulating" effect of "Polar pink" or the "recuperative" effect of "Russian grey" be taken with reservation pending more definite experimental proof.

W. E. Story, Jr. (*Chairman*).

References

(1) Snowden, Lit. Digest, 46:1578-9, June 21, 1913.

(2) Pressey, "Influence of Color upon Mental and Motor Efficiency."

(3) Ellis, "The Psychology of Yellow," Pop. Science, 68:456-65, May, 1906.

Troland, "The Psychology of Color," Sci. Amer. Sup., Aug. 24, 1918.

Keller, "Application of Physiology of Color Vision to Modern Art." Pop. Sci. 83:450-65, Nov., 1913.

Harris, "Colored Thinking," Canad. M. 47:395-6, Oct. 18, 1918.

Sullivan, Sci. Amer. 110:165, Feb. 21, 1914.

Plummer, Sci. Amer. 112:343, April 10, 1915. All on Color Music.

Editorial Rev. of Rev. 51:747-7, June, 1915.

Abney, "Researches in Colour Vision," Longmans, Green and Co., 1913.

Luckiesh, "Color and Its Applications" (containing many references to the different phases of the color problem), P. Van Nostrand Company, 1915.

Ives, "Resolution of Mixed Colors by Differential Visual Diffusivity." Phil. Mag. 35:413, May 1918.

Jones, "Brightness." I. E. S. Trans., 1920.

MOTION PICTURE NOMENCLATURE

Society of Motion Picture Engineers.

Terms proposed by Nomenclature Committee of the Society of Motion Picture Engineers for consideration at the October, 1921, convention, and on approval for official adoption by the Society.

ACTION—The director's signal to the players to begin performing.

ARC—A column of very hot light-emitting gas, carrying an electric current sustaining this condition.

BACK FOCUS—The distance from the principal focus of a lens to its nearest face.

BUSINESS—Action by the player; e. g., business of shutting door.

CAMERA—The director's signal to the photographer to begin taking the scene.

CHANGE-OVER—In projection, the act of changing from one projector to another without interrupting the continuity of projection.

CINE—A prefix used in description of the motion picture art or apparatus.

CLOSE-UP—Scene or action taken with the character close to the camera.

CONDENSER—The lens combination which deflects the diverging rays of the luminant into the projection lens.

Collecting Lens—The lens of the condenser nearest the light source.

Converging Lens—The lens nearest the objective.

Center Lens—The lens of a three lens combination, lying between the collecting lens and the converging lens.

CUTTING—Editing a picture by the elimination of unacceptable film.

CUT-BACK—Scenes which are returns to previous action.

CUT-IN—Anything inserted in a scene which breaks its continuity.

DEVELOPING—Making visible the latent image in an exposed film.

DISSOLVE—The gradual transition of one scene into another.

DIRECTOR—The person who superintends the actual production of the motion picture.

DOUBLE EXPOSURE—The exposure of a negative film in a camera twice before development.

DOUBLE PRINTING—The exposure of a sensitive film under two negatives prior to development.

DOUSER—The manually operated door in the projecting machine which intercepts the light before it reaches the film.

DUPE—A negative made from a positive.

EFFECTIVE APERTURE—The largest diameter of a lens available under the conditions considered.

EQUIVALENT FOCUS—The equivalent *focal length* of a combination of lenses is equal to the focal length of a simple thin lens which will give the same sized image of a distant object as does the combination of lenses.

EXTERIOR—A scene supposed to be taken out of doors.

FADE-IN—The gradual appearance of the picture from darkness to full screen brilliancy.

FADE-OUT—The gradual disappearance of the screen-picture into blackness. (The reverse of fade-in).

FEATURE—A pictured story a plurality of reels in length.

FILM—The ribbon upon which the series of related picture elements are recorded.

FIXING—Making permanent the developed image in a film.

FLAT—A section of painted canvas, light board, or the like, used in building sets.

FLASH—A short scene, usually not more than three to five feet of film.

FLASH-BACK—A very short cut-back.

FOCAL LENGTH—The distance from the center of a simple thin lens to the image formed by it of a distant object.

FOOTAGE—Film length measured in feet.

FRAME (noun)—A single picture of the series on a motion picture film.

FRAME (verb)—To bring a frame into register with the aperture during the period of rest.

FRAME LINE—The dividing line between two frames.

INTERMITTENT SPROCKET—The sprocket which engages the film to give it intermittent movement at the picture aperture.

IRIS—An adjustable lens diaphragm.

IRISING—Gradually narrowing the field of vision by a mechanical device on the camera.

INSERT—Any photographic subject, without action, in the film.

INTERIOR—Any scene supposed to be taken inside a building.

JOINING—Splicing into a continuous strip (usually 1,000 feet) the separate scenes, titles, etc., of a picture.

LANTERN PICTURE—A still picture projected on a screen by means of an optical lantern or stereopticon.

LANTERN SLIDE (Stereo slide)—A transparent picture for projection by an optical lantern or stereopticon.

LEADER—That piece of blank film attached to the beginning of the picture series.

LENS, SIMPLE—A lens consisting of but a single piece of glass or other transparent medium.

LENS, COMPOUND—The combination of a number of simple lenses.

LIGHT BEAM—A bundle of light rays which has a cross section of appreciable size.

LIGHT RAY—A stream of light of unappreciable cross section.

LOCATION—A place other than a studio selected for a motion picture scene.

MAGAZINE VALVE—The film opening in the magazine of a motion picture projector.

MASKS—Opaque plates of various sizes and shapes used in the camera to protect parts of the negative from exposure.

MOTION PICTURE—The representation of an object by the rapid presentation to the eye of a series of pictures showing the object at successive intervals of time.

MULTIPLE-REEL—A photoplay of more than a thousand feet of film in length.

NEGATIVE—The developed film, after being exposed in a camera.

NEGATIVE STOCK—Light sensitive film intended for motion picture camera use.

OBJECTIVE—The simple or compound lens nearest an object which forms an image of it.

OPAQUE PROJECTOR (often called "Post card projector")—A lantern for optically projecting opaque objects, picture post cards, or the like.

OPTICAL AXIS—The straight line through the centers of the light source, lenses, diaphragm, etc., of an optical system, to which their planes are in general perpendicular.

PAM—Contraction for panorama.

PANORAM—To rotate a motion picture camera about an axis perpendicular to the tripod top.

PHOTOPLAY—A story in motion pictures.

POSITIVE—The developed film, after being printed from a negative.

POSITIVE STOCK—The light-sensitive film intended to be printed upon through a negative.

PRE-RELEASE—A picture not yet released for general public showing.

PRINT—Same as "positive."

PRODUCER—The maker of motion pictures.

PROGRAM—The complete show for a single audience.

PROJECTOR—An optical lantern equipped with mechanism for suitably moving motion picture film across the projected light.

PROPS—Contraction of properties. Objects used as accessories in a play.

PROJECTION DISTANCE—The distance between the projection lens and the surface upon which the image is focused.

PROJECTION LENS—The objective which forms upon the screen an image of the lantern slide, or film, or other object under examination.

PROJECTION OBJECTIVE—The objective which forms an image of the lantern slide or film, upon the screen.

REEL—The flanged spool upon which film is wound for use in projecting machines.

REEL—An arbitrary unit of linear measure for film—approximately a thousand feet.

REGISTER—To superimpose exactly.

REGISTER—Any indication produced by simulation.

RELEASE—The publication of a moving picture.

RETAKE—Rephotographing a scene.

REWIND—The process of reversing the winding of a film, usually so that the end to be first projected shall lie on the outside of the roll.

REWINDER—The mechanism by which rewinding is accomplishd.

SCENE—The action taken at a single camera setting.

SCENARIO—A general description of the action of a proposed motion picture.

SCREEN—The surface upon which a picture is optically projected.

SHOOTING A SCENE—Photographing the scene.

SHUTTER—A moving element, usually a disc, which intercepts the light in a motion picture apparatus one or more times for each frame.

Shutter—Working blade—(also variously known as the cutting blade, obscuring blade, main blade, master blade or travel blade). That sector which intercepts the light during the movement of the film at the picture aperture.

Shutter—Intercepting blade—(also known as the flicker blade). That sector which intercepts the light one or more times while the film is stationary.

SINGLE PICTURE CRANK (sometimes referred to as trick spindle)—A crank on a motion picture camera which makes one exposure at each complete revolution.

SLIDE (Stereo slide)—See "Lantern Slide."

SPLICING—Joining the ends of film by cementing.

SPLIT REEL—A reel of film of two or more parts having a different subject on each part.

SPOT—The illuminated area on the aperture plate of motion picture apparatus.

SPROCKET—The toothed cylinder which engages the perforations in the film.

STEREOPTICON—A lantern for projecting transparent pictures; i. e., lantern slides, often a double lantern for dissolving.

STILL—A picture without movement; e. g., a picture from a single negative.

TAKE-UP (noun)—The mechanism which receives and winds the film after it passes the picture aperture.

TAKE-UP (verb)—To wind up the film after it passes the picture aperture in motion picture apparatus.

THROW—See "Projection Distance."

TILT—To rotate a motion picture camera parallel to the direction of film motion and in a vertical plane through the optical axis.

TINTING—Coloring a film by dyeing the gelatine side of it.

TONING—Coloring a film by chemical action on the silver image.

TRICK CRANK—See "Single Picture Crank."

TRICK PICTURE—A motion picture intended to give the effect of action other than that which really took place.

TRAILER—That piece of blank film attached to the end of a picture series.

VISION—A new subject introduced into the main picture, by the gradual fading-in and fading-out of the new subject, as, for example, the visualization of a thought.

WORKING DISTANCE—The distance between an object and the nearest face of a lens forming an image of the object.

A Review of Material Pertaining to Motion Picture Engineering

By R. P. Burrows

SYNOPSIS

This introduces a new endeavor of the society to gather into convenient form a brief synopsis of material published of interest to motion picture engineers. The article reviews for the past five years the publications of societies and trade papers other than those pertaining directly to the motion picture industry.

INTRODUCTION

The original idea was to first search the trade papers outside of those in our industry, such as the Electrical World, The Electrical Review, Scientific American, etc., in which might be found material bearing directly on the industry and second; to review similar material published in the transactions of other engineering societies that might in some manner touch upon subjects of interest. It was decided to cover a period of five years as material previous to that time would probably be very out of date.

While gathering and reviewing the material to be presented, many subjects were found that had some bearing on the industry, but were not directly related to it. These subjects were not reviewed due to lack of time. To properly present most of them would have necessitated a study of the material and the preparation of a discussion showing how such material was applicable to motion picture engineering. Such a task could not be expected from one man. If I were to prepare this material again I would attack the problem from a much different angle. It is with this thought in mind that I wish to make a few recommendations to the society to be followed in the future if you so desire.

This work can be made a very important part of our proceeding and a very valuable one. I think that it can be accomplished with little effort by dividing the work. My recommendation would be that such a review be made a part of the duty of the Reciprocal Relations Committee and as a separate report by them once each year, preferably at the spring meeting. This committee should have a membership sufficiently large so that the work could be divided into parts. For instance one member would be responsible for certain society transactions, another for a group of trade papers, another for books published during the year. The duty of these various members would be to review the material in their various assignments and prepare synopsis and discussions of that material that would have any bearing on our work and not just those subjects that specifically mentioned motion pictures. By such a method we would have gathered together in time such a fund of information as could not be found elsewhere in the industry.

The synopsis offered do not follow this line I am sorry to say because the experience gained in gathering this material has been responsible for reaching the conclusions given. It has been endeavored to group it into convenient form giving the title and author's name at the beginning of each synopsis. The name and date of the publication in which the complete article may be found is abbreviated as ER, 3-16-16—The Electrical Review—March 16, 1916. The following abbreviations are used:

ER—Electrical Review
SA—Scientific American
IES—Transactions of the Illuminating Engineering Association
GER—General Electric Review
EW—Electrical World
SA—Science & Abstract
EJ—Electrical Journal

IE—Illuminating Engineering Transactions of the London IES
AM—American Machinist
IA—Iron Age
MW—Metal Workers
JFI—Journal of the Franklin Institution.

PROJECTORS

Professional

Motor-Driven Motion Picture Projectors.....ER 11-20-15

Describes the new projector developed by the Precision Mach. Co.

Motor-Driven Motion Picture Machines.....ER 12-25-15
Discusses the percentage of motor-driven machines in use. The conclusion reached is that they are extensively used.

A Motion Picture Projector that is different.....SA 2-3-17
A description of a new projector which embodies essentials of other projectors but has new features such as the absence of an upper film magazine; a method eliminating a train of gears and a new feature of framing.

Portable

New Cycle in Motion Picture Projection.....SA 3-23-18

A description of a new portable projection machine embodying three principal features; beauty of picture, simplicity of design and safety.

Development in Portable Cinema Outfits.....IE 6-20
A description of portable projectors in use in England at the end of the war with special reference to the traveling and "suitcase" type. This states that pictures shown are very promising but indicates possibilities for further design, especially in lens systems and screens The vital point of the paper was safety. The home office Explosives Dept. pointed out that the greatest danger lies in handling the film to and from the machines and the storage of film. Only the introduction of non-flamable film will overcome this danger.

Making of a Moving Picture Machine.....AM 10-10 & 24-18
This is a popular article on the manufacture of a portable moving picture machine with a specific description of one type of machine.

PROJECTION

General

The Projector Lantern—J. B. Taylor.....IES, 1916, Vol. 11.

An outline of the principal developments and operation of the projection lantern giving the requirements of screens and the psychological aspects of vision with respect to projection.

Projection Engineering—R. B. Chillas, Jr.....IES, 1916, Vol. 11.
Deals with certain requirements for the light sources in order to produce a steady picture on the screen of an intensity restful to the eye and yet sufficient to give clear detail. Characteristics of alternating and direct current arcs are analyzed. The light distribution

within the lantern and through the lens is described. Several suggestions for the improvement of the optical arrangements of the lantern are given.

Test of Kinematograph Apparatus—F. LaPorte.....IES, 4-14
Gives the result of tests on a variety of projectors using Tungsten, Nernst, and arc lamps consuming from 16 to 3,000 watts. In each case the size of the image and brightness of screens are given, both with the apparatus stationary and in motion. Not only did the actual luminous flux vary widely but the effect in terms of the light actually projected on the screen varied from 13 to 277 MM per watt.

Motion Picture Projection—Report of Committee on Progress
IES, 1919, Vol. 15
A new arc lamp, which is small size, has a watercooled copper ring for the negative pole. This ring is placed concentrically around the end of the positive carbon. The arc is struck by an automatic adjustment between the ring, but travels around it producing a central small crater in the positive carbon and at the same time distributing the heat over the circumference of the cooling ring. The latter does not obstruct in any way the beam of light from the crater and any ordinary methods of projection may be used. In a lamp of standard size with a voltage of 55 and a current of 43 amps. a positive crater 17.6 sq. mm. was formed with a brightness of 700 candles per square millimeter. The cooling of the annular ring is produced automatically through convection currents of quite a small quantity of water. The feed of the carbon is automatic and the feeding mechanism is controlled by means of a thermo-couple. The overall weight is about 45 lbs. (20 kilos). For work in taking motion pictures outside the regular studio, a portable arc lamp has been devised, which has twin carbons, cored with a magnesium compound, and the unit is said to produce from 8,000 to 15,000 candlepower, depending upon how the carbons are connected up. To avoid harsh shadows the light is filtered through a spun glass screen and the whole apparatus can be concentrated into a package easily carried in one hand. It is claimed that three of these lamps will illuminate a stage 30 ft. by 50 ft. A self-contained twin-arc lamp for use by photographers and motion picture studios is fitted with a triangular shadow-breaking device which softens the double shadows usually prominent when twin arcs are used without diffusers. The lamp has two doors which act as reflectors and any desired angle of light reflection may be obtained by adjustment of these doors. Among the conclusions reached were that candlepower is directly proportional to the current within the limits of operating range, within this range the candle-power decreases with increasing size of carbon at a given current. The maximum efficiency is obtained when a carbon is burned just below the penciling

point; crater area is directly proportional to the current for a given size carbon and increases with the size of the carbon at the same current.

Optics

Optic Projection as a Problem in Illumination—J. A. Orange
IES, 1916, Vol. 11

This paper is a plea for abandonment of the prevalent "point source" treatment of projection (searchlights, transparency projectors) in favor of the rational source surface method. A brief note on the searchlight and more complete discussion of the magic lantern and moving picture machines are presented in illustration. The bearing of lens sizes and positions on the intensity and distribution of illumination at the screen is discussed. The screen itself is considered as a factor; the inadvisability of very high picture brightness and the possibilities of different sources with especial reference to the case of tungsten filament lamps as against the carbon arc are discussed. The fundamental relations involved in illumination calculations are given.

Screens

Diffusing Media—Projection and Focusing Screens
Report IES, Committee on Glare

The distribution curves and efficiencies of various wall and cloth coverings, mirrors and special preparations used as projection screens are given. The properties of the ideal screen are discussed. Data are given on diffusing transmission screens for focusing and projection.

Cinematographic Screen that does not need Darkness...SA, 4-1-16
Describes a screen on which pictures can be projected in a room which is fully illuminated. This is a translucent screen.

Movie Engineering—The Selection of the Most Efficient Screen Surface—L. W. McOmber.....EW, 5-20-16
In this article the author discusses the three prime requisites for motion picture screens which are: 1. The furnishing of a bright attractive picture to the audience. 2. The elimination of eyestrain on the part of the spectator to as great an extent as possible, and, 3. the highest efficiency of reflection on the screen.

Multiplying the Average Motion Picture screen by six—SA, 8-16-19
Describes a large outdoor screen erected in Cincinnati.

Projection Screens for Cinema Work.....IE, 6-20
This is a synopsis of a paper presented to the Optical Society in England in which screen surfaces are analyzed for diffusion efficiency reflecting power and total efficiency. Tabular data of the discussion is given.

Carbons

Steady Motion Picture Carbons.....EW, 11-10-17

With motion picture lamps it has been customary to have the negative carbon somewhat smaller than the positive upper in order to have the consumption of the electrodes approximately equal and secure a stationary focal point. Ben Perris, Lakewood, O., shows in his patent 1,241,740 how not only can the requirements for the equal burning be produced with electrodes having a relative cross section of 4 to 1, but what is more important, an improvement of flicker and spattering of copper upon the condenser lenses can be entirely done away with by copper plating of the negative carbon electrode.

Tungsten Filament Lamps

Incandescent Lamps for Moving Pictures—W. T. Birdsall—EJ, 6-16

The incandescent lamp has for some time practically superceded other forms of illumination for low power projection work requiring concentrated light sources. Recently the Mazda C Lamp has been applied to moving picture work, and tests have shown that it can be made to yield even better results than the direct current arc. The purpose of the present article is to outline the technical limitations which are encountered in making this new application.

Mazda Lamps for Motion Picture Projection—L. C. Porter

GER, 12-17

An analysis of the difficulties encountered in successfully developing an incandescent lighting system to replace the arc lighting system which has been commonly used. The description of the manner in which these difficulties have been surmounted, by the development of a special incandescent lamp and condenser and the addition of spherical mirror, is very interesting. The article is concluded by a table comparing the detailed operating cost of the new incandescent lamp with that of the arc lamp and showing that the former type of lamp projector is more economical to operate than the latter.

Motion Picture Projection with Tungsten Filament Lamps—J. T. Caldwell, A. R. Dennington, J. A. Orange & L. C. Porter

IES-18

The past year has seen the beginning of an extensive introduction of tungsten lamps into the moving picture projection field. The development of lamps for this purpose had its inception in the G. E. Company's Research Laboratory at Schenectady. It has been carried through to the commercially successful stage by the engineers of this and other manufacturers co-operating in the development of incandescent lamps. This account of the development is drawn up by those engineers and rounded out by a representative of the labora-

tory. This paper covers the historical developments of the carbon arc motion picture projector and points out some aspects of the art of projection that favors the replacement of the arc by the incandescent lamp. The types of lamps used together with illustrations of the auxiliary equipment and data on the advantages and disadvantages of the several systems form the major part of the paper. An appendix gives some important commercial aspects of the subject.

Gas Filled Lamps for the Movies.....EW, 4-13-19

The two advantages of gas-filled lamps are great light-giving power and extremely high-intrinsic brilliancy which makes it possible to reduce the source of light to very small dimensions. This quality is of great importance in projecting pictures at high magnification. This makes it easy to get good definition with an optical system of moderate dimensions.

Mazda Lamps for Motion Picture Projection—L. C. Porter

GER, 7-19

This describes some changes that have been made in Mazda Lamps for Motion Picture projection as the result of further research and experience from service installations. The lamp wattage has been increased to 900 and a tubular bulb used in place of the spherical bulb, permitting a nearer setting of the mirror and consequently a greater volume of light. Some improvements in control apparatus have also been effected and are described in this article.

Photometric

Photometric Methods in connection with Magic Lantern and Motion Picture Outfits and a simple method of studying the intrinsic brilliancy of the projection source.—J. A. Orange.....JFI, 1916

This article gives the practical details of the apparatus required and the manipulation for the purposes indicated in the title.

Eyestrain

The Illumination of Motion Picture Projectors—J. F. Martin

IES, 1913

After outlining the operating characteristics and requirements of the light sources of projection lamps. the color of light and the character of screen best adapted to projecting motion pictures this paper is concluded with a brief discussion of the question, Does the motion picture cause eyestrain? Observation, the author states, indicates that constant viewing of motion pictures tends not only to develop the semi-voluntary muscles of the eye but to give them greater endurance and more rapid action. He adds, though, that pronounced flicker in pictures sometimes experienced by patrons of motion pictures caused by unsteadiness of the pictures and defects in the films, indicates so much fatigue which usually recedes without any result-

ing injury. The author suggests an examination of the eyes of lantern operators to determine the nature and extent of the effect of motion pictures on the eye.

Efficiency of the Eye—C. E. Ferree & Gertrude Rand....IES, 1915
The belief that motion pictures subject the eyes to undue strain is too prevalent to need more than mention in passing. The initially dark adapted and highly sensitized eye, the comparatively brilliant screen with its dark surrounding field, the flickering light and the shifting and very often unsteady pictures, differences in surface brightness of considerable magnitude in the field of vision cause loss of efficiency and produce discomfort.

The report of the Joint Committee on Eyestrain in Cinemas
IE, 6-20
This is a very complete discussion on the subject of the principle point covered as to the effect of proximity of seats to screen. Other points discussed are the origin of flicker, the effect of imperfection in film and apparatus, the desirable brightness of the screen and the conditions of artificial lighting. Two recommendations are given: 1. that the angle of elevation, subtended at the eye of any person seated in the front row by the length of the vertical line dropped from the center of the top edge of the picture to the horizontal plane passing through the observer's eye shall not exceed 35 degrees. The height of the eye above the floor level being assumed to be 3 feet 6 inches and second, that provided No. 1 is complied with the angle between the vertical plane containing the upper edge of the picture, and the vertical plane containing the observer's eyes and the remote end of the upper edge of the picture should not be less than 25 degrees. It is further suggested that the maximum distance from the eye to the screen should be such that the subtended angle should not be less than 5 degrees or that the most remote seat should not exceed a distance equal to twelve times the height of the screen.

Report of the Cinema Commission of Inquiry.....IE, 9-17
The points of interest in this inquiry are a study of the order of illumination on the screen, the desirable contrast between the screen and the brightness of the surroundings; the influence of flicker; the duration of entertainments, distance and angle at which screen should be viewed.

ACCESSORIES

Converting Apparatus

Motion Picture Problems Solved (Throw-over arrangement for operating two motion picture machines).....ER, 8-21-15
A four-pole double-throw switch, a rectifier for motion picture work, has been developed so that a change can be made from one reel to

the other without any break in the picture. This also gives an account of how light can be projected to show the film at the best advantage.

Compensarc for Motion Picture Projectors—C. Walford
ER, 8-7-25

The motion picture machine with its high-power arc lamp has given rise to the need of a special motor generator. In this article is an explanation of the theory of the D.C. Arc.

Current Supply for Motion Picture Machines—H. R. Johnson
GE, Rev. 9-15

The following is a comprehensive article that furnishes data on the present-day illumination and operation requirements of projection and describes the commercial electrical apparatus that fulfills these requirements.

Relating Converting Apparatus for Motion Picture Arcs
EW, 3-25-16

This article is a record of latest developments and improvements in manufacturers products used in the electrical field.

G. E. Compensarc for Mazda Projection Lamp.....ER, 4-13-18
This compensarc, known as the Type I, has been developed in conjunction with incandescent lamps so that this compensarc and the Mazda lamp form a complete working unit capable of giving the utmost light and lamp life.

The compensarc reduces the voltage and keeps the current constant.

Compensarc set for Changing A.C. to D.C. for Motion Picture Projection .....ER, 2-23-18
Describes a development of an A.C. to D.C. compensarc equipment which permits series operation of two-arc type projection lamps while projection is being changed from one lamp to the other.

Arc Controls

Arc Light Controller for Motion Picture Projection...SA, 3-20-15
An apparatus has been developed so that if there is any variation in voltage across the arc terminals an adjustment of the carbons is secured by means of a motor-driven controller where a 1/16 H.P. electric motor is connected directly across the arc and is so wound that it will respond to a wide range of potentials.

Automatic Arc Controller for Motion Picture Projection Lamps
ER, 12-2-16

To overcome the many difficulties in projecting pictures there has been placed on the market a machine which is an automatic feed device for projection arcs. This outfit can be applied to any projec-

tion lamp. It operates entirely automatically and drives a perfect and steady feed of carbons, thus giving the best light and greatest economy.

Reels

A Non-winding Motion Picture Reel.....ER, 1-30-15

This describes a non-rewinding motion picture reel in which the film is drawn from the center of the reel.

Horting Automatic Stop Motor-Driven Picture Film Rewind
EW, 8-12-16

This describes an improved type of motor-driven rewind.

THEATRES

General

Modern Electrical Equipment in Picture Theatres.....ER, 8-24-18

This is a description of the equipment in the Progress Theatre, Oakland, Calif.

Chicago Ventilation Commission's First Report.....MW, 4-30-15

This is a review of the above mentioned report with the summary of recommendations reached regarding the proper ventilation of theatres. This report was made after five years of study and experiments and is well worth reading.

Lighting

Lighting a Motion Picture Theatre.....EW, July 15, 1916

The problem of lighting a Motion Picture Theatre correctly is that of adequately lighting an auditorium which must never be brilliant, save during intermissions, and must be subdued so as never to detract from the effectiveness of the picture on the screen, nor in any way to reach the eyes of the audience in such manner as to interfere in any way with their comfort.

Interior Lighting for Motion Picture Theatres..EW, May 17, 1919

This article tells how the lighting of a motion picture theatre differs from that in a legitimate theatre, due to the fact that sufficient light must be furnished to permit the audience to find its way about, but the distribution of this light must be such as not to interfere with the picture on the screen. It tells of the requirements which it must fulfill and an illustration of the method in which the requirements are filled.

Analysis of Motion Picture Theatre Lighting—L. W. McOmber
EW, 7-15-22, 1916

This is the result of a study that brings out the importance of engineering considerations in solving special lighting problems of the

picture theatre. Data is given that should aid in the selection of equipment and a suitable screen. The article deals principally with a description of the lighting of one theatre by the totally indirect method.

Safety

Automatic Control System that precludes Fire and Panic in Picture Theatres .....SA, JI, 29-16

Describes the invention of Anton Szeliga of New York, which is a device for the prevention of fire and panics in motion picture theatres. This apparatus prevents films in the projection room from igniting or exploding.

STUDIOS

General

A motion Picture Studio which changes with the weather SA, 11-10-17

The manipulation of a switch not only converts a motion picture studio into a wind and rain-proof enclosure, but it also makes artificial light under the same condition as sunlight so that no new arrangements or manipulations are necessary in this particular. This was invented by Mr. I. Bernstein of Los Angeles.

Generals in Shadowland Warfare—A. C. Lescarboura SA, May 5, 1917

This article tells how an outdoor stage is prepared and selected, how the picture is taken and handled.

Artisans of the Motion Picture Film.....SA, Sept. 2-16

This article is similar to the one previous.

Lighting

Industrial Lighting with Mercury Vapor Lamps—Motion Picture Studios—W. A. D. Evans.....IES, 1915

In the studio the first operation in the manufacture of the film is performed and as mercury vapor lamps are extensively used for this class of work, data regarding them may be of interest.

As far as is known, there are in the U. S. about 50 studios using artificial light for the taking of motion pictures. Of these 43 use mercury vapor lamps either entirely or in combination with other systems. Nearly all use at least one or two large arc lamps to obtain special lighting effects.

Electric Lighting of a Movie Studio—W. E. Brewster EW, Nov. 25, 16

Use of photographic blue bulb lamps in the plant of Wharton, Inc., Ithaca, N. Y. Provisions for flexible lamp location and control of light.

Lighting a Large Motion Picture Studio—J. H. Sandridge
ER, 1-6-17

The methods used for control and handling of the light equipment of the Rothacker Studio is described in this article.

Motion Picture Studio Lighting Layout.....EW, 4-28-17
Description of a gas-filled lamp installation using two types of lighting frames, one suspended from an overhead trolley and the other adapted to move about the floor.

Artificial Lighting of Moving Picture Studios—W. A. D. Evans
IE, 6-15

A general discussion of this subject giving relations of costs of producing, describing camera lines and the use of Mercury Vapor Lamps.

Photography

Making a Motion Picture of a 100th Second Shutter Exposure
SA, 6-3-16

An apparatus for the above purpose has been developed which has an aluminum disc mounted on a vertical shaft driven at 50 revolutions per second constant speed by a specially governed electric motor. Around the edge of the disc are 20 small mirrors. Since there are 20 mirrors and they revolve 50 times in a second, there are 1,000 reflected planes per second which will fall in the path of a horizontal light ray supplied by a small electric arc.

Camera for Filming Rapidly Moving Objects.....SA, 3-29-19
This is a description of the Akeley camera designed for filming rapidly moving objects such as motorboats, aeroplanes, athletes, etc.

Shooting the Photoplay—A. C. Lescarboura.....SA, 9-15-17
This paper describes how motion pictures have advanced since the industry was in its infancy with regard to film manufacture, lens manufacture, shutters, etc.

Micro Photoplays—A. C. Lescarboura.....SA, 1-19-18
This article shows how motion pictures are taken with the aid of a microscope.

How Moving Photomicrographs Are Taken.....IA, Aug. 8, 18
This is a description of apparatus used for recording the gradual changes in a metal structure when subjected to repeated bending stresses. The article is profusely illustrated.

Color Photography

Using both sides of Film to Produce Motion Pictures in Color
SA, 8-11-17

This describes the method used by Mr. Kelley to produce motion pictures in color by using both sides of the film.

Laboratory

From the Camera to the Screen—A. C. Lescarboura...SA, 12-8-17
This describes the precaution necessary in the laboratory for the production of a clean, clear and steady picture.

Eliminating Guesswork in Cinematography.....SA, 12-9-16
Heretofore guesswork was predominating in motion pictures, but this has been eliminated to a great extent by scientific methods in cinematography. In view of these conditions a road equipment has been invented which was installed in a Pullman car and bought by a motion picture company. This eliminates having to erect a laboratory at each place a picture is being "shot" and avoids the limitation of a small, poorly equipped laboratory and the difficulties arising from sending the work to the home laboratory hundred and thousands of miles away.

EDUCATIONAL

Electrical Pheonomena Illustrated by Motion Picture Films
ER, 9-7-18

Motion picture films are recommended by C. F. Bishop of Rochester, N. Y., for the purpose of illustrating such pheonomena as are inherently invisible in character or otherwise difficult to demonstrate in actual visible form, such as parallel lines in electrical circuits for rating each conductor and partly fills in the space between these lines of varying density to indicate different degrees of magnetization.

Recording Sound on Motion Picture Film.....SA, 12-22-18
A clear stereoscopic flickerless image on the screen in natural colors accompanied by a true and convincing reproduction of the sound emitted by the successive images and sound waves being in perfect synchronism describes the eventual goal of cinematography. In other words, absolute realism in the ideal and everything which does not quite come up to the ideal is but temporary and can only serve as a milestone in the steady progress.

Cinema Service for Manufacturers.....SA, 6-21-19
On account of the U. S. being so large, industrial and manufacturing films are more extensively made than in other countries. This article tells how American people become familiar with all parts of their country through the movies.

The Motion Picture and its Relations to Industrial Problems—E. A. Deuch
A popular discussion of the subject referring to the instruction of salesmen, the solving of efficiency problems, obtaining of help, etc

MISCELLANEOUS

How a Rheostat for Motion Picture Machines may serve as a Heater in a Ticket Booth—T. J. Gochlan.....ER, 12-22-17

This article tells how a rheostat can be used in heating a ticket booth.

Facts vs. Fiction in Motion Pictures.....SA, Aug. 19, 16

An article telling how the American public is leaning toward the appreciation of scientific pictures along with the regular program.

Film Exchange Regulations.....AM, 7-17-18

This is a digest of the National Fire Protective Association Report on tests of films in vaults and containers and a copy of the Chicago code.

Lighting for Motion Picture Theatres

By J. L. Stair

THE photoplay is becoming an instrument of culture with practically unlimited possibilities. With the growing appreciation of the public, the demand for special effects in the presentation of the photoplay is increasing. Resourceful producers and exhibitors are supplying the demands of a critical public for more genuine art and as a result the silent drama demands for its temple a specially constructed building of architectural magnificence equipped with the best mechanical devices, most perfect ventilation, and an attractive and harmonious system of illumination.

Because the theatre is used largely at night, light is one of the best means of making it attractive. The lighting of the theatre has ceased to be merely a matter of engineering detail. The illuminating engineer and others responsible for the lighting of a playhouse, must possess imagination. The illumination effects should be designed to supplement the drama by producing an atmosphere harmonizing with the play and not detracting from it.

The problem of lighting in the photoplay house differs in many ways from that in the so-called legitimate theatre, especially with reference to the auditorium, orchestra pit, stage and proscenium arch, and consists not so much in providing the proper and sufficient intensity of light, but in securing the correct gradation of light and color.

No attempt will be made here to trace the history of the theatre lighting art; the development of which has been, in the opinion of some, retarded by playhouse traditions; but to present some of the methods of present practice in theatre lighting. The development of lamps and their accessories has brought about many important changes in the lighting of this class of interior, and their application has taught us much about the value of lighting as a medium for advertising, as well as for artistic and spectacular effects.

The best results in the art of theatre lighting can be attained only by careful study of the various means that can be used, and by noting the effects of each method, on the actual operation of the house. The method that furnishes satisfactory illumination, that is novel and effective, is greatly desired by the prospective theatre owner.

It should be kept in mind that good lighting properly applied, will do as much as any other feature to elevate the theatre to the point of its maximum usefulness and attractiveness.

Lighting the Exterior

Even from a distance of several blocks away, patrons can be attracted to the playhouse by special lighting effects. The recent

development of flood lighting, using projector units, provides the theatre owner a means of effective advertising in addition to the usual signs, etc. The system gives very attractive results at a comparatively small cost, and does not mar the building surface since in most cases the Units can be placed in an accessible location at a considerable distance from the building.

The method of bringing the building into prominence by outlining with bare lamps has been used. Although this method is satisfactory in some cases, it does not light the building, but rather obliterates the details of design. The newer scheme for lighting

Fig. 1—Flood-lighting of theatre at night by means of projectors of type shown in Fig. 2. Note how clearly the detail of the building is shown.

the exterior, an example of which is shown in Figure 1, fixes the shape, design and location of the building on the mind of the observer. This in reality is the first step in the process of attracting the patron to the playhouse.

In some instances, the most effective results are obtained by combining outline lighting with the flood-lighting method. Architects are often willing to alter architectural details so that flood-lighting may be employed. In some cases special cornices are constructed or in others architects extend marquees out from the building for the accommodation of the flood-lighting projectors.

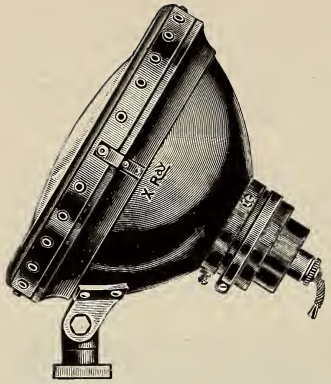


Fig. 2 — A type of flood-lighting projector designed for use with a 250-watt lamp.

An illustration of a type of lighting unit that has been very successful for the flood-lighting of a theatre is shown in Figure 2. The flood-lighting projector is not designed to throw a concentrated beam such as is obtained with a searchlight, but rather to spread the lighting evenly over a large area. Projector units can now be obtained for use with lamps ranging from 200-watts up to 1,500-watts.

Entrance

A bright, warm, and attractive lighting scheme should be adopted for the entrance of the theatre. This is probably the brightest spot in the whole lighting scheme of the playhouse with the possible exception of the stage, and the lighting should therefore be carefully planned so as to have the maximum attractiveness with a minimum of glare.

One of the fundamental points to be kept in mind in planning theatre lighting is that the whole illumination scheme should be arranged so that a suitable transition in brightness is afforded in passing from the street through the entrance and lobby into the dimly lighted auditorium. The visual shocks that come with sudden changes of intensity will be practically eliminated if this principle is carefully applied. The eye thus becomes accustomed to the darkened surroundings gradually.

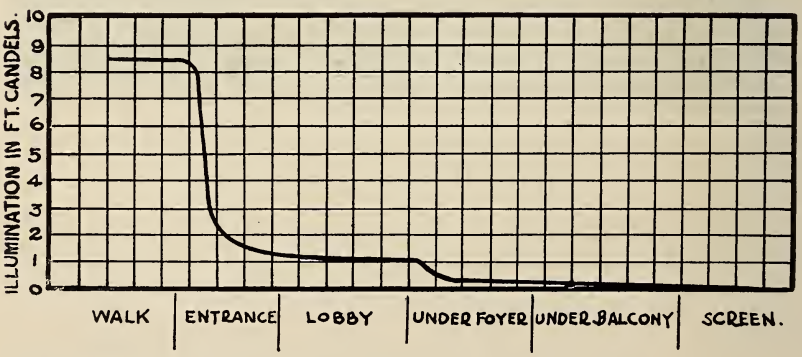


Fig. 3—Chart showing variation of illumination intensity from entrance to screen in photoplay house.

The accompanying diagram in Figure 3, shows in a graphical way the small steps or differences in illumination value in various

portions of the Merrill Theatre in Milwaukee, Wis. It will be noted that the intensity varies from 8 ft. candles at the entrance to practically zero at the screen.

Lobby and Foyer

The foyer and lobby afford probably better than any other portion of the theatre an opportunity for working out novel and individual methods of lighting treatment. Attractive and impressive results can be obtained here without the use of glaring exposed lamps that so often create an atmosphere of garish cheapness. The intensity of light should be more subdued than for the entrance of the theatre as in Fig. 3, thus reducing the contrast between the bright street illumination and that of the dimly lighted auditorium. Many schemes have been adopted for lobby lighting. Hanging fixtures of metal, composition, glass or crystal, illumination from coves and

Fig. 4—Lobby of theatre showing use of the pedestal lighting method.

cornices, lighting standards, portable lamps, wall brackets, etc. The lobby shown in figure 4, illustrates the use of special lighting standards. This lobby is 30 ft. by 50 ft.—has a ceiling 20 ft. high. Four 8 ft. standards light the entire space. Each is equipped with four 100-watt lamps burning in silvered indirect lighting reflectors.

When we consider that the wattage expenditure is only slightly more than one watt per square foot, this is a very effective and economical way to illuminate the lobby. The method eliminates glare and tends to bring out the decorative touches that have been carefully added to make the lobby attractive.

With much the same effect, but with the lighting accomplished in an entirely different manner, the lobby in Figure 5 is given as an example of cove or cornice lighting. Cove lighting has been known

Fig. 5—Lobby and palm room illustrating use of cove lighting and indirect portable art lamps.

for many years to be an ideal method, but only since the production of the high efficiency lamps have the many possibilities for illumination of interiors by this method become apparent. One of the pleasing features of the cove method is that it uniformly illuminates the ceiling and when properly planned no splashes of light or shadows are present to indicate the position of the individual lighting units in the cove. Cove lighting requires more careful planning than the ordinary lighting problem in order that the results be economical and pleasing.

Restroom and Lounge

Comfort is the essential feature to be kept in mind in the illumination of restrooms and lounges. The lighting should be of a subdued intensity. One of the usual methods consists in the employment of decorative units such as portable lamps and wall brackets that provide a tinted lighting effect.

A typical example of lounge lighting is shown in Figure 6—the Men's Room in a theatre in Milwaukee. In this case a silk bowl

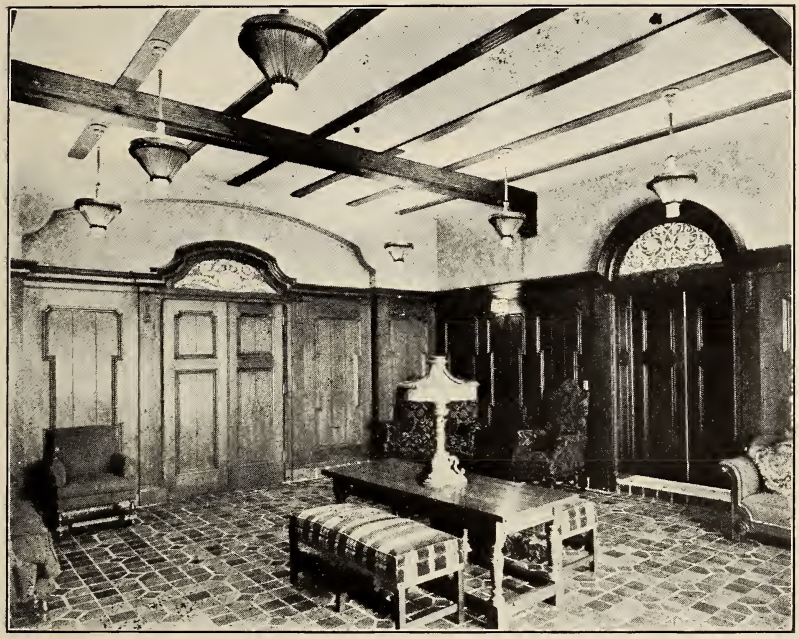


Fig. 6—Men's Lounge in a theatre—a rich lighting effect is produced by silk fixtures.

fixture produces general illumination of a diffused character. The warmth of the colored silk bowl adds to the artistic value of the interior.

Auditorium

The lighting of the Auditorium has probably been given more attention recently than that of any other portion of the theatre. Recent practices in Auditorium lighting have led to the more or less general adoption of the indirect lighting system as the logical method for this portion of the theatre, using variations as to color effects, as well as controllable gradations of the intensity of the light. The lighting may be accomplished by means of hanging fixtures, from

cornices, coves, wall brackets, balcony rails, etc., depending upon the personal liking of the owner or the architectural influences of the interior.

It has come to be a necessity that at least two intensities of illumination be provided for the Auditorium. First, a dim lighting during progress of the show, and a brighter intensity for intermissions. Dim lighting while the pictures are being shown assists the ushers in seating the patrons, produces a more cheerful place of entertainment and gives to the patrons a sense of safety and security. A dim illumination can be carefully calculated to be of such intensity as not to interfere in any way with the clearness of the picture on the screen, and furthermore not reduce the ability of clearly seeing about the room.

Dim and bright lighting effects are easily obtained by employing dimmers or by wiring lamps in the lighting units on separate circuits, controlled from the operator's box.

In a careful investigation recently made by Mr. L. A. Jones of the Research Laboratories of the Eastman Kodak Co. the following conclusions regarding intensities for Auditoriums were arrived at:

The illuminations should vary on 1/10 ft. candle at the front of the theatre to 2/10 ft. candles at the rear while the pictures are being exhibited. With the intensity graduated as mentioned ordinary newspaper print can be read with ease by an observer. This amount of illumination will not decrease in any way the quality of the projected picture. However, in order to accomplish results that are satisfactory, the light must be properly distributed throughout the interior and all bright areas or points of intense light should be eliminated.

Figure 7 shows a sectional view of theatre and illustrates the

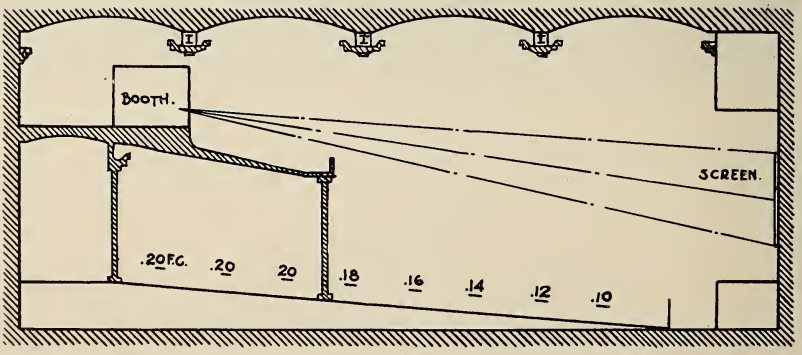


Fig. 7—Diagram showing proper gradation of illumination intensity from rear to front of house for dim lighting arrangement.

method of theatre illumination based upon the findings of Mr. Jones. Mr. Jones states that to best accomplish the illumination values indi-

cated above very extended effective light sources are required, such as illuminated ceilings and walls. These are produced most economically by use of the indirect system of lighting.

In addition to the requirements of the Auditorium illumination color effects are coming to be more essential in the production of photoplays, in suiting to the lighting to the action and the atmosphere of the play. The theatre of the future will no doubt utilize harmonious lighting effects in the presentations. The means for doing this are now within the reach of exhibitors.

The present fashions in theatre lighting are no doubt giving the greatest impetus to the use of colored or tinted illumination and there exists a great opportunity in the playhouse for reaching and developing in the public an appreciation for color. The art of light will educate the average eye to gradations of color to which it is now blind.

There is every reason to believe that lighting can be made to change with the emotional changes of the play, melting one mood into another. For instance, for night scenes, illumination in the Auditorium should be diminished to preserve the proper brightness ratio, and in the case of sun-set or sun-rise, the effect may be increased by a simultaneous increase of the brightness in the Auditorium.

Modern practice shows that colored lights are sometimes used entirely for Auditorium lighting, with the white or untinted light entirely eliminated. In some cases a blue light is used for the dim illumination and in other instances amber tone is employed while the pictures are being shown.

We have been handicapped more or less in the use of color lighting in the general illumination of the theatre, because of the mediums with which we have had to work. These mediums have in the past included colored fabrics, gelatine screens, dipped lamps and sheet glass, giving fairly satisfactory results. However, since the development of the high efficiency lamps, the heat factor has become very important and the color devices mentioned above will not entirely fill the requirements because of burning of the mediums. This condition of course brings about a loss in the character and efficiency of colored light.

Dipped and colored lamps are useful where the heat factor is not great, but they do not meet the requirements in all cases, especially where the maintenance is a large item, and replacements are expensive.

Because of the lack of stability in color effects, and because of replacements in the medium, a new type of color slide of special heat resisting glass with the color incorporated in it has recently been developed, and seems to have solved many difficult problems for this class of installation.

With the proper application of these plates for the lighting of

the Auditorium and the stage, a more rapid advancement in the art of color in lighting is possible without the handicap of the fading out of the medium.

The following examples of Auditorium lighting will be of interest as indicating the various methods that are being employed for producing the lighting results.

As a first example, Figure 8 shows how the hanging lighting

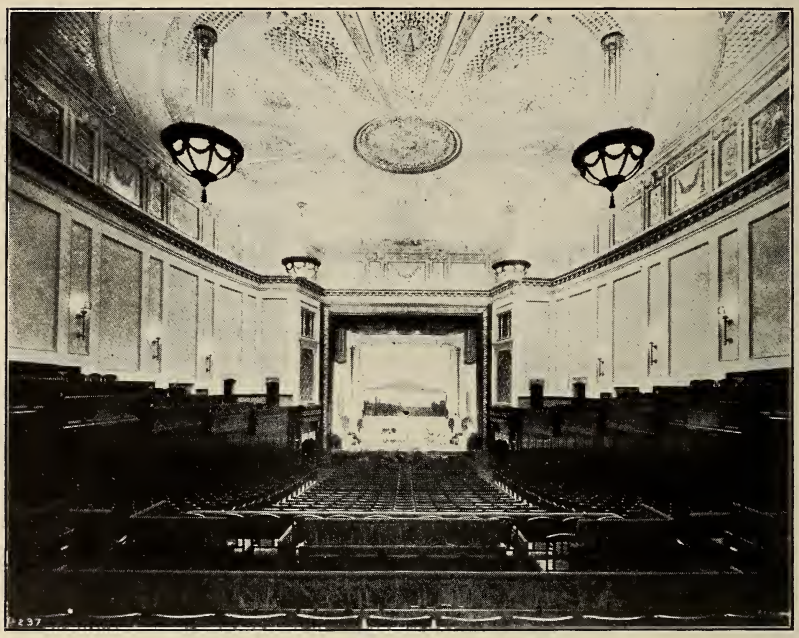
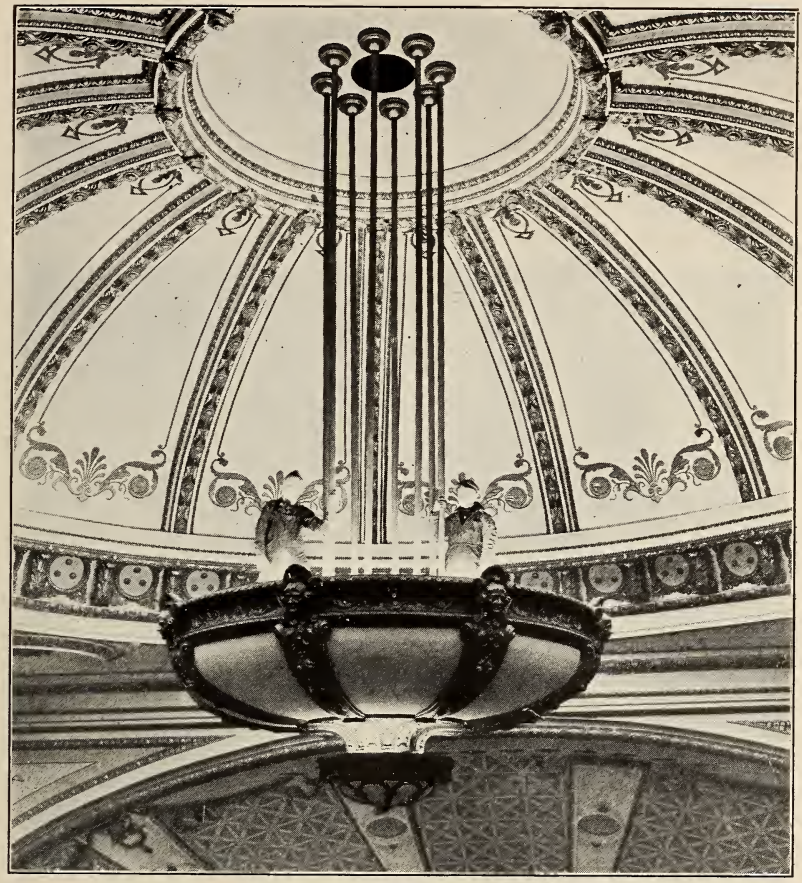


Fig. 8—Theatre auditorium illuminated by four large fixtures, each six feet in diameter.

fixture is employed. In this theatre, four large luminous type indirect fixtures 72 inches in diameter furnish white and colored lighting effects. The color combinations are obtained by using special colored slides placed above the reflector units in the bowl. In this particular case the lamps for the color units burn in a horizontal position, thus concentrating the maximum of heat on the color slide. This condition brought about the necessity of securing a color medium that is practically permanent, not only as far as the color itself is concerned, but also one that would not crack with subjection to the high temperature.

Another interesting example of lighting with fixtures is to be found in the theatre illustrated in Figure 9. The fixture shown is probably the largest indirect lighting fixture ever installed. This



Fg. 9—Large fifteen foot fixture that illuminates practically entire auditorium of a Milwaukee theatre.

enormous unit is 15 ft. in diameter and contains 118 lamps. The main bowl has 100-200 watt lamps in special indirect lighting reflectors. The lower bowl contains 18-60 watt lamps. This lower bowl serves to illuminate the large bowl and is also used for emergency lighting.

The large fixture is suspended by eight 2-inch pipes, 25 ft. long, and hangs in the center of the dome of the Auditorium—weighs approximately 5,500 pounds, and is finished in ivory and gold. The auxiliary lighting in other portions of the theatre not affected by the central fixture is done by means of sixteen smaller fixtures similar to the large one.

Color lighting is also a feature of this installation. In the central fixture the 100-200 watt lamps are divided into four groups of 25 each, with red, amber, blue and white. The colors are secured

by natural colored cover glasses, placed above the reflectors. The same scheme is carried out for the small fixtures. It might be mentioned in this connection that one of the interesting treatments of the lighting in this theatre is the flood-lighting of the proscenium arch by twelve 1,000-watt projector units.

In one of the theatres in Illinois all of the principal lighting of the Auditorium with the exception of the under the balcony section, and for the proscenium arch, comes from a large crystal

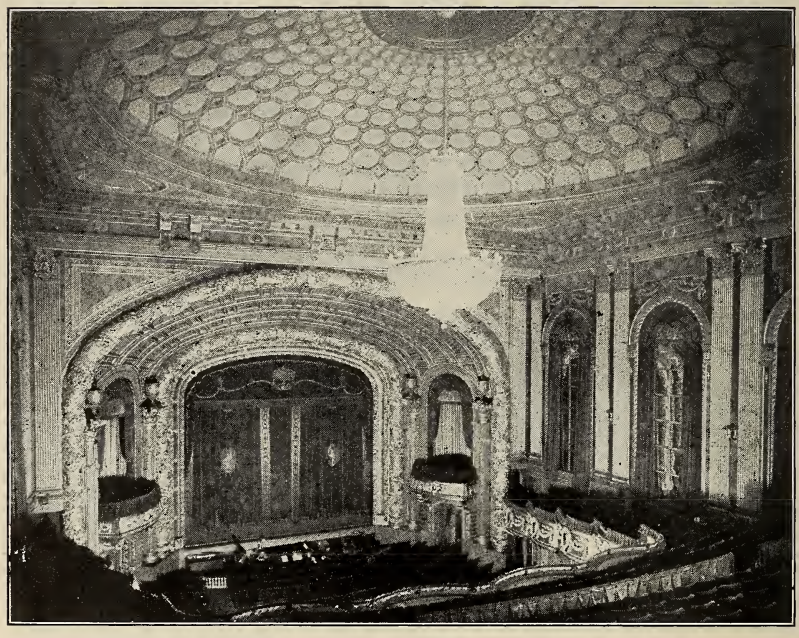


Fig. 10—A massive crystal fixture seventeen feet in height furnishes all the principal illumination for this auditorium.

chandelier, as shown in Figure 10. This fixture has a total capacity of about 16,350 watts, measures 9 ft. in diameter, and 17 ft. in height. The wiring is arranged in 18 circuits, and serves the many individual lighting units consisting of indirect reflecting devices, color attachments, and the lamps in the interior of the fixture body.

Crystal pieces are being employed in many of the modern theatres. It is therefore of interest to know how the modern crystal chandelier may be employed as an effective lighting fixture without robbing it of its artistic character. Figure 11 shows the interior arrangements and will give an idea how the fixture may be retained in all its beauty and yet have the added qualities of being light-giving and glareless. This fixture illustrates a radical departure in theatre lighting, and also shows what can be done in combining the artist's skill with practical illumination effects.

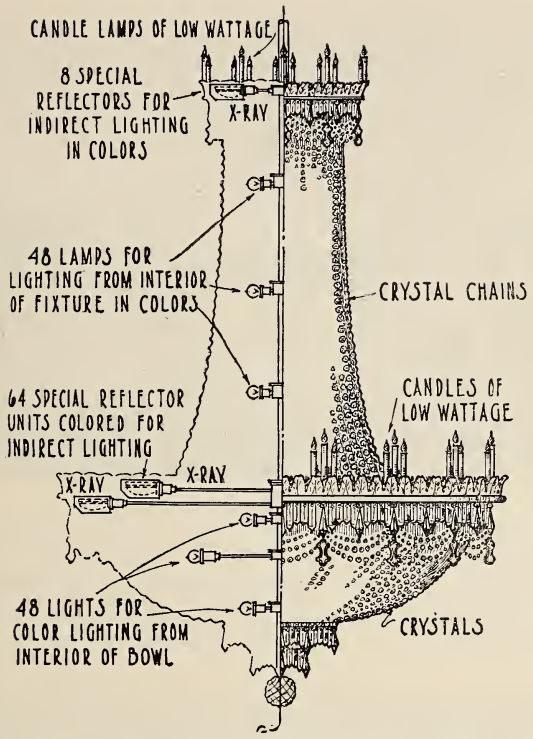


Fig. 11—Sketch of the large crystal fixture shown in Fig. 10—Note how with various lighting units modern illumination effects are combined with artistic chandelier design.

The general tendency in theatre lighting is to get away entirely from the use of hanging fixtures, employing methods of concealed lighting. Some of the most interesting and pleasing installations have been made without fixtures. For the theatre Auditorium especially, the elimination of the hanging fixtures increases the spacious appearance of the interior, and also offers the least obstruction to the view of the patrons and to the projection of the pictures. One of the interesting examples of this form of lighting is illustrated in Figure 12. The lighting equipment in this case is contained in the cornice near the ceiling on two sides of the room. Four series of lighting units are employed, one for white lighting, and one each of the colors, red, green and blue. Standard 200-watt Mazda lamps are used in silvered one-piece corrugated reflectors. Color screens of glass are mounted over the openings of lighting units.

A system of dimmers in the circuit of the lighting units provides an easy means by which the lighting units may be lighted so gradually that one is scarcely aware of the increasing intensity. Then the colors of red, green, blue, and various combinations of these colors can be passed through to clear white lighting gradually receding to almost actual darkness, without a noticeable flicker.

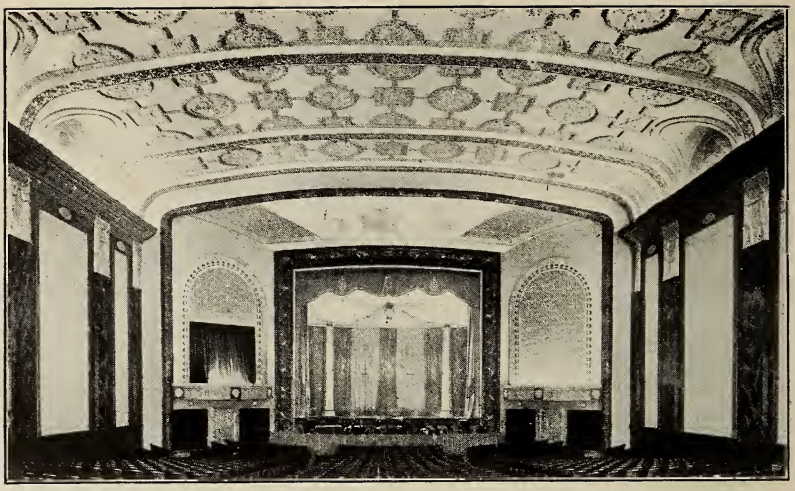


Fig. 12—Auditorium of theatre illuminated by cove lighting method.

Figure 13 shows another example of the cove lighting method in which the reflecting devices and lamps are installed in coves at the base of the ceiling domes. In this Theatre, the Tivoli of Chicago,

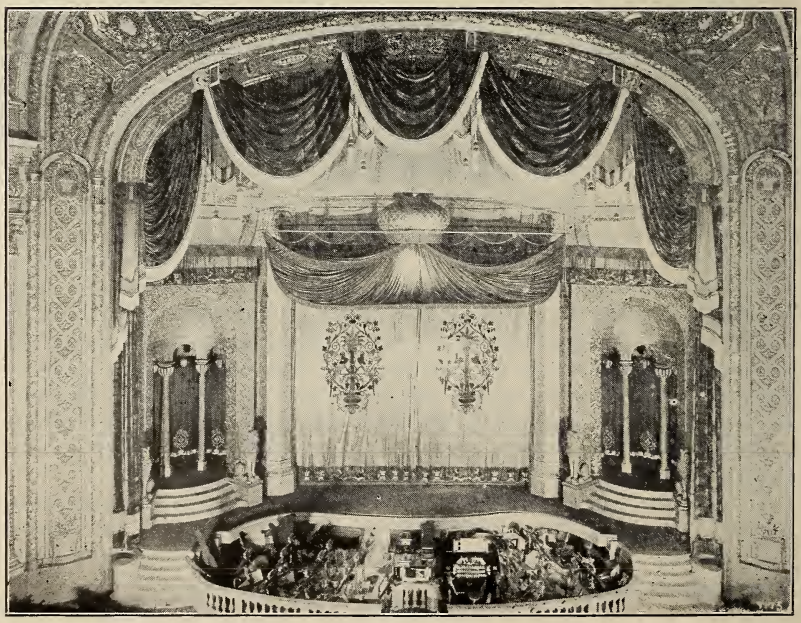


Fig. 13—Main illumination for this theatre is from coves in the ceiling domes.

the main dome contains a large number of 60-watt lamps on 8-inch centers with special mirrored reflectors. The smaller dome contains the same type of equipment with 50-watt lamps.

The finish of the ceiling of the domes is aluminum leaf and gives extremely pleasing lighting effects when the various colors are played upon it. Many special features are employed for other portions of the theatre, such as the side balustrade, under the balcony, the organ grills, the steps at the side of the stage, etc.

An interesting way in which lighting effects may be obtained from ornamental wall boxes is shown in Figure 14. It will be noted that the side walls of the room are divided architecturally into panels which provide a pleasing arrangement for the lighting units. One wall box equipped with special reflectors is located in each of the panels. Each of the wall boxes contains three lighting units wired on two circuits. One unit provides the dim illumination during the performance, while all the units burning during the intermission give

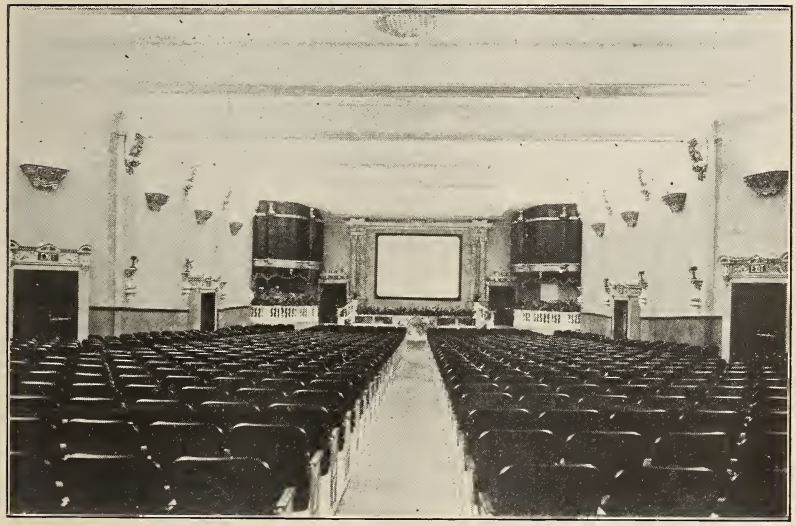


Fig. 14—Ornamental wall boxes contain the lighting units—a unique way of solving the illumination problem.

a bright illumination. In installations of this character, boxes should be located a sufficient distance from the ceiling to produce an even brightness over the ceiling area.

By working the lighting units into the decorative elements of the room, all lamps are entirely hidden from view, yet the interior is illuminated by means of equipment which appears to be a decorative feature rather than a lighting fixture.

Another method which offers great possibilities in the lighting

of theatre auditorium is illustrated in Figure 15. This balcony view shows that considerable ingenuity has been used in concealing lamps and reflector equipment along the front of the balcony rail. To one seated in the balcony no lamps are visible and yet the auditorium is flooded with diffused illumination. When viewing the balcony from the stage it is not at once apparent that the projecting compartment has been added so well does it fit into the architectural treatment of the house.

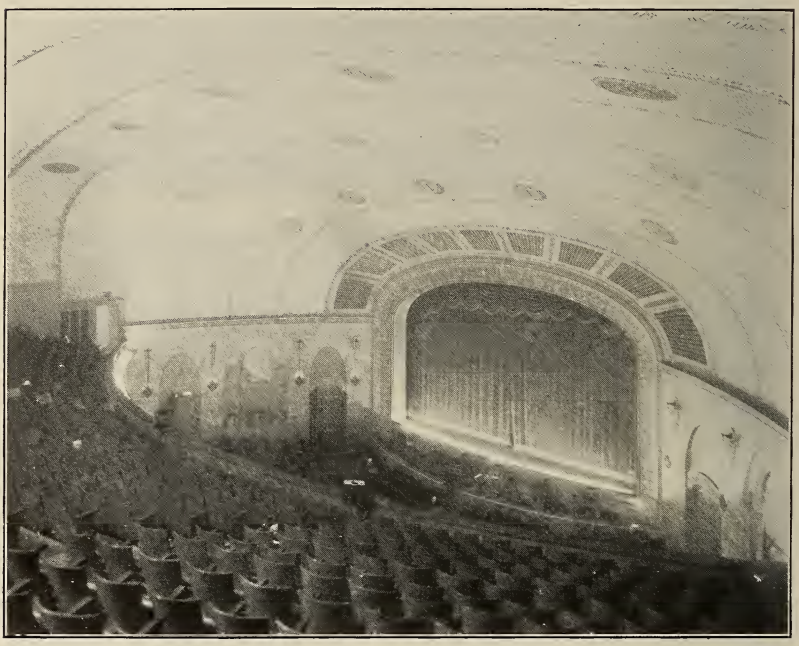


Fig. 15—An auditorium in which an unusual lighting method has been employed—units are concealed in the balcony front.

Special Lighting Features

Many of the larger theatres are providing special arrangements whereby a flood of light can be concentrated upon the orchestra during the overtures and other special musical numbers. With the auditorium light subdued the orchestra is brought out in bold contrast to the surroundings tending to keep the attention of the audience upon the musical number. An example of an orchestra pit lighted in this manner is shown in Figure 16. The methods for producing this concentration of light are various. Sometimes projectors are concealed above the ceiling, the light beams coming through an opening. When the orchestra pit is well back under the proscenium arch the units are placed among the borders.

In many theatres a feature is made of the lighting of the proscenium arch in order to bring out the beauty of the architectural treatment. A unique method recently installed is shown in Figure 17. The units in this case were placed in the false boxes at either side of the arch. The location of the boxes can be seen by referring

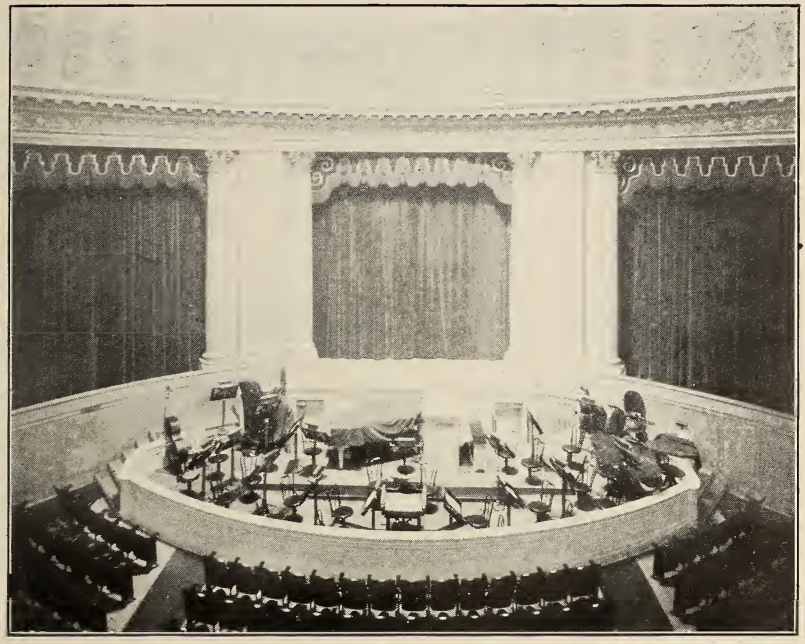


Fig. 16—Orchestra pit with concentrated light from projector units overhead.

to Figure 10. It will be noted that the supporting device for the reflector units in this case are adjustable, making it possible to point the reflected beam in any direction to secure the proper placing and distribution to the light from the units. Special heat-resisting colored

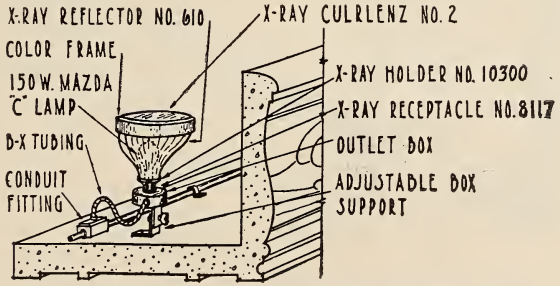


Fig. 17—Perspective view of a section of a proscenium box showing one of the units for illuminating the arch.

cover plates are used above the reflectors, thus allowing for color effects to be played upon the arch in conjunction with corresponding tints in the auditorium from the principle lighting fixture.

It is possible in practically every theatre to add interesting artistic touches with special lighting effects. An example of interest is to be found in the theatre illustrated in Figure 13, where the steps leading up on each side of the stage are made of glass and illuminated from below. The light is in colors and changes to correspond with the changes in the general illumination of the interior.

A simple means of getting an effective result upon the screen, draperies and curtains is accomplished by a projecting colored light from the lantern.

Stage Lighting

The stage is the center of interest. The picture, the orchestra, the settings for prologues and special features, combine to make the stage the point about which everything focuses.

In the lighting of the stage, the theatre has probably kept closer to traditional methods than in any other department of the playhouse. Methods have been devised of recent years however, that depart very radically from the old time usage. The results produced by the newer schemes are different and far in advance of the ordinary effects, and at a great saving for current. The lighting of the stage is now receiving more careful thought as to the artistic and economical possibilities. With the newer methods each lamp has its own reflector, thus making possible the most effective use of the light delivered from the lamp.

The losses in control and quantity of light with the old type borders was enormous. The later methods have consideration for efficiency in stage lighting. They are scientifically based upon the fundamental principles of light control. The illumination of the stage by direct reflection with its remarkably exact control of light

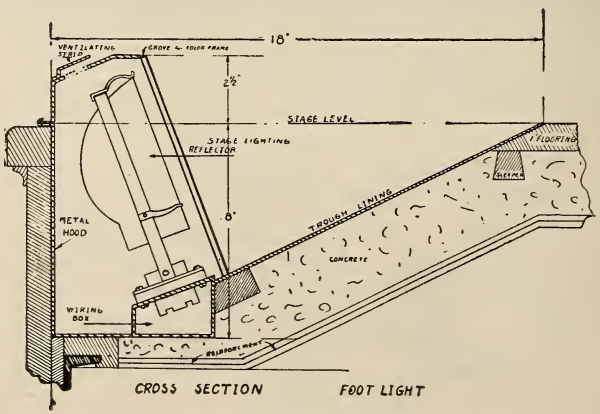


Fig. 18—Cross section of new type of stage footlight.

seems to be a step in the right direction as against the old borders whose rays were unconfined.

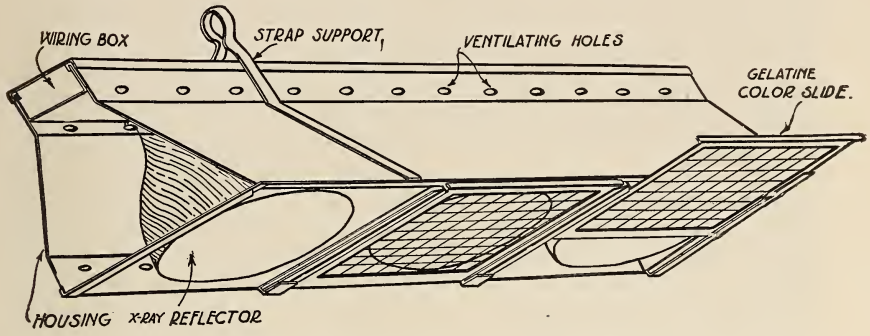


Fig. 19—Perspective sketch of border light equipment showing reflectors, removable color slides, wiring box and strap support.

A type of foot-light of new design is shown in Figure 18 and a border in Figure 19. As will be noted, these types of lighting equipment contain a reflector for each individual lamp, enabling the producer to direct the light where it will be most effective.

Conclusion

Illuminating Engineers, Electricians, and the men who have charge of lighting affairs around the theatre, are playing a part of increasingly greater importance. It is too often the case in the lighting of theatres that the method of illumination is selected after the building is almost completed, with the result that the lighting equipment in no way fits or harmonizes with the other features of the building. It should be kept carefully in mind that the lighting is just as essential as the seats, draperies, etc. The cooperative efforts of the theatre owner, architect, and contractor in making a careful study of the problem along with other details, will be rewarded by most surprising and pleasing results. The effect will be a more suitable, more economical, and more efficient lighting system.

Discussion of G. L. Stair's Paper

Mr. Richardson: The paper is valuable in its way. It tells us what we are doing, but we already pretty well know that. I am disappointed in that more of the errors and their remedies have not been dealt with. There is in my opinion more abuse in theatre lighting from the projection view point, than perhaps any other one thing in the entire industry, and these abuses which are working intolerable injury to the photoplay on the screen have not been mentioned at all in Mr. Stair's paper. It is not necessary to go to the small theatres to discover error in auditorium lighting. You will find it in the biggest and best theatres in the United States. In fact you will find it in its very worst possible form in some of the best theatres. Side lights in objectionable form have been very largely educated out of existence in the large theatres, but they still exist in hundreds, if not thousands, of small theatres. Such lights are a plain, unadulterated outrage on common sense.

In the large theatres they still have orchestra music lighting which is also a crime against common sense. We have men building photoplay palaces which cost anywhere from a quarter of a million to a million dollars and have orchestras of anywhere from twenty to forty, or even fifty musicians, right up against the screen, with, to all intents and purposes, open music stands and with high power incandescent lights glaring down upon white sheet music which reflects the light to the screen, or to light surroundings which re-reflect light back to the screen, with the result that the contrast of the picture is greatly injured or utterly ruined. In my work among projectionists one of the greatest defects I have to encounter is the fact that projectionists in big theatres are discouraged by this very thing. No longer ago than a month I went up to the projection room of one of the big Broadway theatres in New York City to speak to the projectionist with regard to a fault in his work. He listened to my criticism and then said: "Look here, Richardson, why in the name of God should I try to put high class work on that thing down there," and he pointed to the screen, on the bottom half of which shadows were not shadows but merely a great smudge due to the light reflected from sheet music.

I talked to the theatre manager and he says: "Well, I will turn the music stands around," but he doesn't seem to understand that when he turns them around the light will still strike the sheet music and be reflected back to the light screen surroundings and will then be re-reflected back to the screen, so that he has merely ameliorated the condition a little.

I do believe this society is badly in need of a paper pointing out the faults in theatre lighting from the projection point of view. I grant you that the general lighting of theatre auditoriums has been enormously improved during the past few years and is really coming down to something like common sense, but the orchestra pit lighting still is, particularly in large theaters, terrible. Many of the small theatres still have side lights in objectionable form and we have the over-bright exit lights often located close to the screen.

The paper is valuable but it hasn't pointed out the very worst crimes we commit in theatre lighting and their remedies, and when I say "crimes" I mean exactly that, for not only are these things a crime against the photoplay, but against the eye-sight of the audiences as well.

Mr. L. C. Porter: Along the point Mr. Richardson has brought out, about the lighting of music, I had occasion some time ago to study that a little bit. It is a very difficult problem, to find any means of lighting music so that it will not either reflect onto the screen or be an eye-sore for the audience.

We carried on some experiments at Woolsey Hall, at Yale University, in one case where we used projectors, really spot-lights, from above, about 70 feet above where the orchestra was playing, and projected a small light down unto each piece of music, and had the music turned at such an angle that the audience could not see it. That was fairly effective, certainly a large improvement over having individual lights on each sheet of music.

There was still, however, some diffusion of light, and we tried to get away from that by having photostat copies of the music made, so that the notes were in white and the sheet in brown. That reduced it somewhat.

I think, however, that deserves close study, and if someone can find a means of accomplishing the result by using translucent music or something of that sort, there will be a commercial field which will be well worth the endeavor and expense put into it.

Mr. Egeler: The two previous speakers have called attention to points of probable faults in theatre lighting which exist.

I think that the fact that these apparent faults in lighting exist calls attention to the necessity for much greater cooperation between those who design the projection system and those who design the lighting, and those who design the theatre.

The lighting system in the theater has two principal functions; the first is to furnish that utilitarian lighting which is necessary to enable the audience to see their way about the theatre, during the projection of films, before and after the performance; and the second during intermission, to furnish pleasing effects. It is my personal impression that the stress which has been laid upon theater lighting has been more to get lighting systems which will give beautiful lighting effects and the actual lighting purposes of the system, from the utilitarian standpoint has been overlooked.

I have in mind a certain theatre in which there was apparently no co-ordinated effort by the projection engineers and the architects to produce lighting effects on the screen and in the auditorium which would operate satisfactorily as a unit. In this theater the architects provided for a relatively high intensity of lighting during the projection of the motion pictures. They arranged the lighting circuits so that during the projection of the pictures the illumination in the auditorium was about one footcandle, approximately one-eighth of the illumination received when all of the lights were burning. I can qualify this illumination value by saying that ordinarily an

intensity of one-tenth of a footcandle is sufficient for reading programs. So much light from the lighting fixtures reached the screen during the projection of the pictures that the contrasts were greatly reduced. To remedy this condition either of two things could be done; one is to increase the amount of light projected from the motion picture machine; the other is to reduce the auditorium illumination. To utilize the first scheme would mean useless additional cost for energy in view of the fact that much less general illumination would be entirely satisfactory.

After endeavoring to operate the original lighting systems satisfactorily for a day or so, the management changed the lighting circuits so that there was one watt on the low intensity circuit where there had been ten before. The resulting illumination of in the order of one-tenth of a footcandle was sufficient during the projection of pictures with much more satisfactory results on the screen.

In the matter of theater design possibly we need some entirely different arrangements as to the placing of the orchestra. Perhaps we have followed the long existing practice of the so-called legitimate theater too much, and in the motion picture theater should follow some radically different lines, with regard to the location of the orchestra with respect to the screen. This is but one idea of a possibility it may be desirable to investigate. I believe we are yet young in the game and we have not fully developed motion picture theater lighting and auditorium design.

An important consideration which should not be overlooked is the maintenance of the lighting equipment. I do not believe that it is generally appreciated that lack of maintenance is very costly. A considerable amount of money may be spent on the installation of a lighting system to produce first-class lighting effects, yet after a year's operation this same system may be giving but 50 or 60 per cent of the initial illumination, because the lighting fixtures have not been regularly cleaned. Dust accumulations on the lamps and reflectors, and whereas originally good lighting effects are obtained through the combination of light of different colors, with the presence of dirt on the units not only is the intensity of the light decreased, but some of the special color effects may be affected in various degrees.

The remedy is provision for regular cleaning service. The frequency of cleaning is dependent upon the amount of dust prevailing in the particular community in which the theater is located; in many cases a monthly cleaning of the fixtures is satisfactory. But in any case a regular schedule should be established in order that the illumination which the lighting units were designed to give, will be maintained.

Motion Picture Cameras

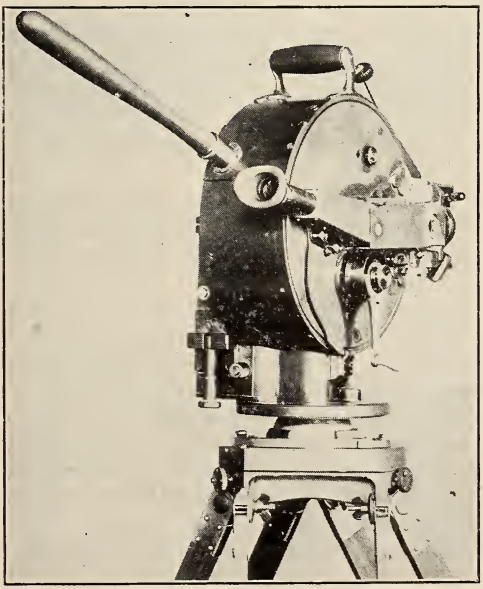
By Carl Louis Gregory, F. R. P. S.

THE ever widening fields to which the motion picture is being adapted has induced manufacturers and inventors to bring forth many new camera designs and to make many improvements in the old standard designs.

It is the purpose of this paper to list briefly the more important developments in camera design which have appeared recently. It would be impossible, of course, in a paper of this kind to list every improvement and invention directly related to motion picture cameras—the list would be too long and voluminous; therefore the writer has endeavored merely to present a brief synopsis leaving to the manufacturers and inventors the task of supplying to those more intimately interested a more minute description of the particular virtues of their products.

Probably no camera, since the making of motion pictures became a business, has shown so many departures from established design as the Akeley Camera, (Akeley Camera Company, 250 West 49th Street, New York), invented by Carl E. Akeley, explorer, sculptor, taxidermist, inventor of the cement gun and Curator of African Animals at the American Museum of Natural History.

Mr. Akeley, while doing extensive scientific work in the jungles of Africa, found the usual type of motion picture camera inadequate and unreliable for the various uses of field work and thereupon, knowing the demands of the photographer, conceived the principle of the present Akeley Camera.



Rear view of Akeley Camera.

The Akeley is the shape of an enlarged round pill box set on edge atop of the tripod. The cover of this box carries a telescopic looking view finder, the turning crank and a footage meter; on one side of the edge of this pill box is a lens hood and on the other a long wooden handle like a policeman's stick; while at the top edge is a carrying handle; on the bottom of the box a supporting arm extends from the base to the center.

This base and arm are the panoramic and tilting devices containing trains of gears with a small flywheel to insure steady movement. Both pan and tilt can be worked simultaneously with the left hand by means of the long wooden handle to follow any object moving obliquely, such as a rising airplane. Both have quick shifts or releases which may be released at will or held at release.

The tripod is constructed on the principle of a truss bridge enabling it to be made light but strong and the truss which gives the rigidity can be released by a catch and the length of the legs changed as readily as pushing a slide trombone.

The tripod head which releases by three quick turn screws carries the camera and panning and tilting devices on a ball and socket joint which can be locked level almost instantaneously irrespective of whether the tripod is placed level or not. Thus the camera can be removed from the tripod for setting on a stump or a rock and still have the advantage of the ball and socket quick-levelling head and the panoram and vertical tilt.

The finder is jointed at the axis of the tilting mechanism and by means of an erecting prism not only keeps the image right side up but also keeps the eyepiece floating at the height of the eye no matter in what direction the camera may be tilted.

Matched twin lenses permit of watching the picture on a ground glass and the focus followed on the ground glass or by a dial which indicates the distance at which the lens is set and changed by a knurled wheel while operating the camera. A slide plate carrying the lenses may be quickly replaced by another plate carrying lenses of any focal length.

The inside magazines hold the standard 200 foot rolls of film and which after exposure it returns to the same box. Replacing magazine and threading takes from 10 to 20 seconds which offsets the necessity of a larger magazine.

The film movement of the single finger type is of positive action, both forward and back. Removal of one screw permits taking this entire unit from camera. Moves the film in 120 degrees of the circle, making possible a shutter of 240 degrees opening.

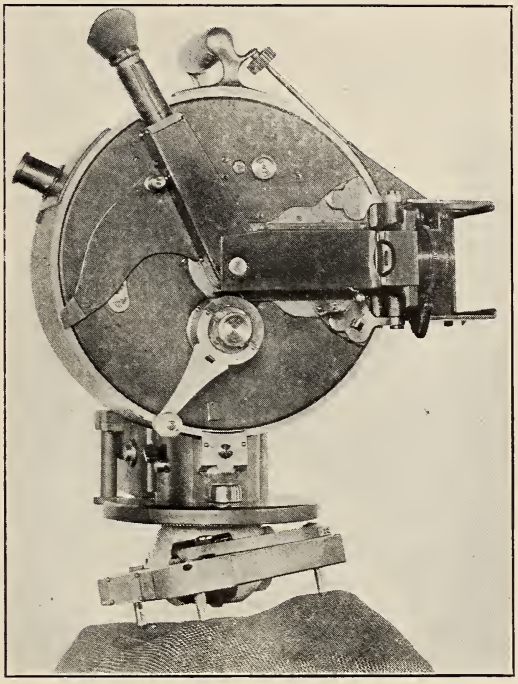
The shutter is of the barrel type and is actually focal plane in character as it encircles the entire camera mechanism just inside the exterior shell and cuts across the focal plane just in front of the film. Its efficiency is much greater than any disk shutter of usuable dimensions could possibly be.

The main outstanding features of this camera which are equalled by no other are: facility with which moving objects may be followed, efficiency of the shutter, ability to work without tripod,

lightness and rigidity of tripod, quickness of loading, and extreme range of tilt and pan.

The next most radical departure from conventional camera design is probably the Russell Camera.

The radical feature of the Russell Camera is the relative arrangement of the lens and film magazines. They are so disposed



Akeley Camera in use without tripod.

that the lens is mounted in a deep recess within the camera casing. The appearance of the camera when closed is that of a rectangular box with an oblong opening in one end in which the lens is set, the position of the magazines on either side of this recess forming a natural sunshade for the lens. Although the lens is placed far back from the front of the camera, the recess in which it is located is of such size that vignetting does not occur.

Vignetting and double exposure devices are placed directly on the front of the camera and do not interfere with the lens carriage, which may be instantly drawn forward, making the lens accessible for cleaning or removal.

The film magazines take Eastman film, 400-foot rolls, direct from the can without removing the wooden spool. Light traps are provided which open automatically one-half inch when the camera is closed, thus eliminating all danger of scratches. All sprockets and rollers and the aperture plates are recessed so that the film surface

touches nowhere throughout its course except on the sprocket holes.

The dissolving shutter dissolves out and in automatically in three different selective speeds. This shutter can also be operated by hand and can be set for any angle from 170 degrees to 0.

Focusing is accomplished by an ocular at the back of the camera which shows the image right side up. By operating a lever at the top of the camera the film, without being removed from the aperture plate, may be swung to one side as the ground glass automatically takes its place. As this operation is accomplished in three seconds and without opening the camera or losing an inch of film by exposure to the light, it is truly a great time and film saver. In focusing, the lens carriage is moved by means of a knurled button on the left of the camera and is so geared as to give a micrometer movement. It can, however, be released instantly for drawing the carriage forward to permit of a change of lens.

A very accurate focusing scale is fitted on the back of the machine and is scaled to feet for those who prefer that method of focusing. This is also an advantage in following the focus while operating the machine.

The take-up is a multiple disc clutch which will take up 400 feet forward or backward with the slightest effort.

Forward and back cranking can be done instantaneously without shifting of belts. Simply reversing the crank automatically releases the forward take-up spool and the back spool takes hold. In going forward, the feed spool likewise is free, which prevents hard cranking when on the roll is larger on one side than the other.

All lenses, from 40 millimeter to 6-inch focus, mounted in similar lens tubes which can be changed in a few seconds, may be used without protruding beyond the front of the camera.

The movement is a new design, doing away with all such wearing parts as cams, guides, slots, springs, etc.

The crank handle is located at the lowest center of gravity, which prevents any torque movement. It is permanently attached to the camera and can be folded out of the way when the camera is not in use.

The Russell Camera is 9 inches high, 7¾ inches wide and 10¾ inches long. It weighs about 20 pounds including a 400 foot roll of film. It is very compact and easily handled.

R. W. Pittman, maker of the Pittman and Photo Cines Cameras, well-known as low priced cameras for topical and semi-professional work, has ready for the market a machine of higher class resembling the Bell and Howell type of all metal camera with multiple lens turret carrying four lenses.

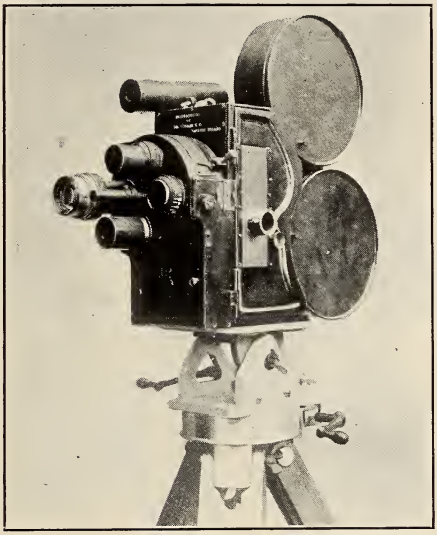
Focusing is accomplished by movement of the lens turret instead of individual focusing mounts and the image is viewed at the aperture by an eyepiece on the side of the camera.

Magazines are separate circular boxes of heavy gauge metal with automatic opening light traps.

A veeder footage counter is built into the machine as well as automatic and hand shutter dissolve, punch, mask slide, etc.

The turret is on a hinged front housing which swings back giving easy access to the shutter and movement mechanism which is easily removable for inspection or repair. The shutter meshes in correct position only, so there is no chance of replacing it out of time with the movement.

Mr. Pittman is also constructing a small camera of 75 foot capacity to be operated by spring motor which may be carried about like a kodak, likewise a vest-pocket camera for taking snapshots on motion picture film.



New Pittman Camera.

The Sociétè Francaise Sept, 86 Avenue Kleber, Paris, have lately put out a camera made by the well known Debrie establishment which holds five meters of film, driven by clock work. It may be loaded in daylight and takes either motion scenes up to twenty feet in length or 300 individual snapshots as may be desired. The lens has an aperture of f3.5 and is set in an accurate focusing mount.

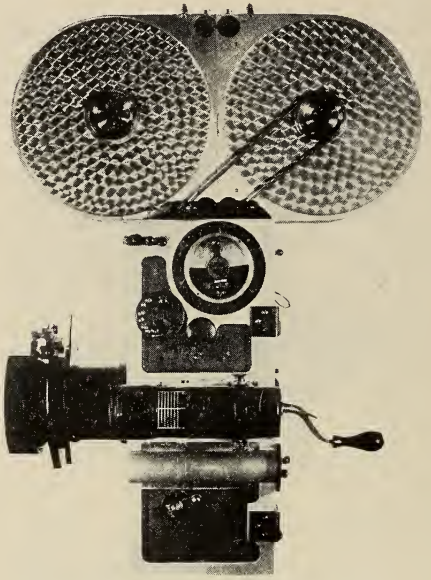
The new model of the professional Debrie Camera appears outwardly much the same as formerly, but is now equipped with automatic shutter dissolve and a number of minor refinements in construction and design.

The French Pathé Camera remains practically the same as before the war but the American Pathé which is the name frequently applied to the Wilart Camera, has forged ahead so consistenly that the old simile no longer applies.

Even the old familiar form of the studio model with overhead exterior magazines will soon become a thing of the past for the new model of the Wilart Camera which will appear shortly has lines distinctively its own and the magazines will be placed inside the camera

so that it can be taken from its case threaded ready for operation.

Some of the advantages of the present Wilart model over the Pathé are as follows: all metal construction, automatic shutter dissolve, all metal film race, automatic opening light traps, focusing



Side elevation of Wilart Camera.

view finder, improved focusing mechanism, ball bearings, Veeder counter, interior masks, etc.

The Wilart Instrument Company is about to put on the market a small motion picture camera using half width film for home use which they expect will have many commercial applications as well. This camera, called the Arcograph, looks like a miniature model of the Bell & Howell and is made with the same care and precision as a professional camera. The pictures made by this little instrument are one-quarter the standard size and the projector of portable type with a reel of film ready threaded is about the size of a lunch box or a bag for a man's bathing suit.

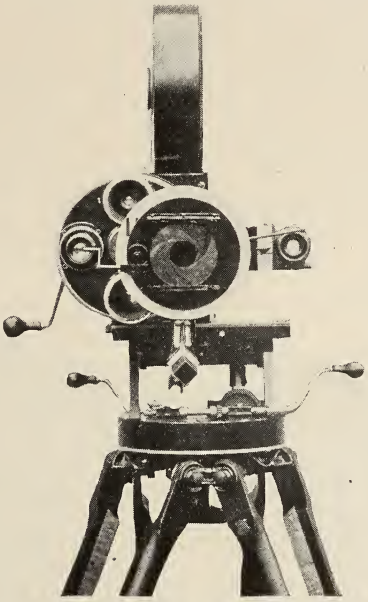
The Universal Camera sold by Burke & James now has an automatic shutter dissolve built into the camera and a turret attachment for carrying extra lenses is now available.

The American Motion Picture Machine Company of Long Island City have recently brought out a turret for four lenses which they attach to the Pathe professional camera.

The Bell & Howell Camera Company announce two outstanding new features which may be attached to any of the Bell & Howell Cameras. These features are the Cinemotor or electric drive and the Ultraspeed attachment.

The Ultraspeed attachment requires some changes in the camera which make it necessary to send the camera to the factory so that

this appliance may be fitted. This is a new shuttle and a step up gear for the crank by the use of which the speed of taking may be increased eight times or more. After being once installed the new ultraspeed device is interchangeable with the old pilot pin shuttle



Bell & Howell Camera fitted with Hollis' automatic Iris and double expansure attachment.

and either ordinary speed pictures or ultraspeed can be made with the same camera.

The Cinemotor or electric camera driving device consists of a compact aluminum housing enclosing a reversible electric motor and controlling devices.

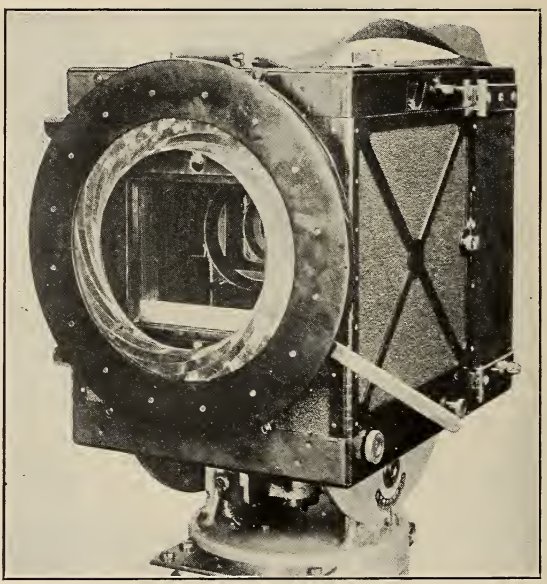
It is equipped with a combination switch making possible the use of either alternating or direct current of 110 volts for operation, which also controls the direction of rotation and for stopping and starting. Positive variable speeds are obtained by the manipulation of a control knob carrying a pointer which traverses a calibrated dial indicating pictures exposed per second, ranging from 1 to 32 and upward. Limit stops provide quick adjustment or shifting to predetermined working speeds, while camera is in motion. A clutch is provided for moving the motor shaft into or out of engagement with the camera shutter shaft without necessitating the stopping of the motor.

A centrifugal governor of extreme sensitiveness insures uniform operation compensating for fluctuations in the supply voltage and at the same time responding instantly to the changes of speed as desired from 24 pictures per second to 4 pictures per second or vice versa may be made instantaneously. The new hand dissolve attach-

ment carries a graduated dial and limit stops which permits the shifting of the degree of opening of the shutter contemporaneously with the variation of the speed of the camera, thus allowing for an even and uniform density of negative.

The operation of the Cinemotor is absolutely free of all vibration and eliminates the unsteadiness of turning, which is a large factor when operating by hand. In this connection it dispenses entirely with the human element and its accompanying variations and completes the chain of mechanically operated apparatus for photographing which further insures the quality of the output.

The unlimited possibilities offered by the Cinemotor along the lines of remote control of the camera is very apparent as the distance at which it can be operated is dependent only on the length of the extension cord supplying the current. By utilizing this advantage the camera man or director can start or stop the camera at any



Front view of Russel Camera.

psychological moment or when "turning" on hazardous scenes where distant control is desirable.

Among the English cameras the Prestwich, Darling, Wrench, Ensign and Moy have altered very little in design.

The Williamson model now has a lens turret carrying three lenses.

Two motor-driven English models are offered, ostensibly to do away with the use of a tripod; one is the electro Gyrospic, which, as its name implies, depends for stability on the action of a Gyroscope, is driven by a small electric motor. As messy storage batteries must be carried it does not present much promise. The other model of

the same type, but driven by compressed air, is the Aeroscope. It can be charged with compressed carbon dioxide on the A Sparklet A principle.

The "Vinten" camera is unique in that instead of being screwed to the tripod head in the normal way, the rotating and tilting mechanism are integral with the camera. It is all metal, has a four lens turret, automatic shutter dissolve, automatic light traps, a movement with one claw only, and the image can be inspected on the film while taking without danger of fogging.

Probably the highest class of English camera is the Sinclair "US" Kinema Camera No. 3. It is an all-metal rectangular box, compact and strong. It has automatic reverse, automatic shutter fade, automatic light traps, interchangeable lens mounts, accurate counter, and all controls are at the back.

Several other camera models are nearly ready for the market but for various reasons their sponsors are not as yet ready to make any announcement concerning them.

Loading Actograph Camera.

Discussion of Gregory's Paper

In addition to cameras, camera attachments are very important, attachments usually used in front of the lens head and called double exposure attachments. The C. P. Gratz (?) people have recently come out with an addition to their exterior iris. The Towheimer of Los Angeles, have a very nice outfit, in which they are continually making changes, and Mr. Hillis of St. Paul, Minn., has one which I believe is an improvement on them all. Mr. Hillis is here and has a model of his new iris diaphragm, and I am sure he would be pleased to show it to those who are interested. It has a great many adjustments, and several adjustments which none of the others have, such as not only being able to close round, but has an automatic square closing device, and quite a number of other improvements, all in a much more compact form than anyone else has yet presented.

If there are any questions or anyone would like to see the photographs which I have, I would be glad to hear them.

Mr. Richardson: I would like to ask you one question, which does not deal directly with your paper, but what do you consider the normal speed of taking pictures? I know it varies widely, but what would you consider the normal in modern practice?

Mr. Gregory: I know that there has been some agitation to increase the speed slightly from 60 feet to 72 feet per minute.

Mr. Richardson: Well, isn't it a fact that nearly all studio work today is done nearer to 72 feet than 60 feet?

Mr. Gregory: I don't believe so.

Mr. Gregory: How do you know from projection that that is so?

Mr. Richardson: Action on the screen.

Mr. Gregory: I find that in most places they project it a great deal faster than it is taken, anyhow.

Mr. Richardson: I will answer that by saying that in "Deception," they have a man up there to watch the picture and instruct the projectionist as to the changes on each scene, and I myself have a copy of the cue sheet on "Deception," and it is almost all of it about seventy, seventy or more; it very seldom runs below 70.

Mr. Gregory: "Deception" was taken in Germany about five years ago. The German machines make eight or nine pictures to the turn, too.

Mr. Palmer: I would like to ask Mr. Gregory if there is any attempt made in these various cameras to accommodate them to the standard film roll as put out by the Eastman Camera Company, so that you don't have to tear out three or four feet of the roll before you can put it in the camera?

Mr. Gregory: Yes, there is in the later models; there is an attempt to introduce the film roll without change, right direct from the box, and using the wooden spool.

Mr. Burrows: Any further discussion?

Mr. Nelson: The only thing I can say is that the Willart, with the Willart you do not need the wooden spool. The ordinary brass

spool goes on the same as the wooden spool that comes in the roll. You take the wooden spool out and slip it on the brass.

Mr. McNabb: There is one thing I think ought to be of interest to the Society, and that is the question of standardization of the spool used in connection with moving picture cameras. It is a question that has come up quite frequently in the past, and I don't think there are any two cameras that have exactly the same ideas along the line of handling the film as it comes from the manufacturer. I know we had the matter up with the Eastman Company about two years ago, to get them to increase the size of their core, which would not affect the size of the can. In other words, they could get 400 feet in the regular can by increasing the size of the spool. We had a number of arguments as to why a larger core or larger spool would be more effective in connection with the use of the film in the camera, not from the feed standpoint, so much as it is from the take-up, and I think it is a matter which the Society ought to work upon in the future, because it is a question of standardization.

Mr. Richardson: In reply to what you said about that 72, I might say that in modern practice in theatres it is impossible to project at 60. It can't be done.

Mr. Gregory: Before someone else asked the question, I was about to say that I really think the public has become so educated to seeing pictures run faster than normal speed, that if the pictures were actually run at normal speed, they would think they were slow.

Mr. Kroesen: Did I understand you, Mr. Gregory, that the speed would ultimately be increased to 70?

Mr. Gregory: I think that is quite likely.

Mr. Kroesen: What effect would that have upon the present method of projecting? In projection today, taking as a matter of argument, we will say we are now photographing at 60 and projecting at 70—the projecting machines and projection apparatus is possibly based upon a set speed. Now, if you photograph, for any reason whatsoever, at 70, that will mean that your projector will possibly operate at a speed of 80 or 90, or possibly higher. That will mean, it seems to me, that the directors and the photographers should get together with the projector manufacturers. It will mean possibly a difference, possibly new models of projectors or intermittent movements. I only offer that as a suggestion, because it all ties in, and inasmuch as they have had to make certain changes to conform to the speed they use at the present time, and if you increase that speed may be 15 or 20%, it will mean an increase in the bearings, possibly, and other things.

Mr. Victor: It appears to me to be a question as between the two reasons advocated for this higher speed in projection. Mr. Gregory suggests that possibly we run projection at a high speed because the public desires to see the speed accelerated in projection. The other contention is that we speed up in order to avoid flicker. It seems to me we should thoroughly analyze the real reason why overspeeding is being done, and then decide what measures should be taken to correct the fault.

Mr. Richardson: Mr. Chairman, I don't think there is any question on that point at all. With the modern high-power screens and modern high intensity light that is demanded and necessary to bring out the modern shades of photography, and do justice to Mr. Gregory's work, under the average conditions, you cannot go very much below 70 without getting a variation in light intesity that is visible to the audience.

I have a great respect for Mr. Gregory's knowledge, his photographic knowledge. I don't believe there is a man in this country who knows more about motion pictures taking than Mr. Gregory, but at the same time I don't believe—I have watched these scenes taken in the studio, not once, but thousands of times. I have seen the same thing put on the screens, and I haven's seen any evidence of over-speeding, and if we drop down to 60, it is not a question of the thing being too slow, it simply drags. You cannot have an actor going this (illustrating) way across the floor, and that is exactly what takes place when you get down to 60.

Mr. Gregory: The speed of 60 has been established so long that most of them never think of it as being a changed standard any more. Certainly the better grade of camera men do take into account the fact that pictures are run a little beyond what we used to call normal speed, and in taking into consideration that fact, they —the comedy companies, as well as the dramatic films—take pictures with the thought in mind of what the effect is going to be when it is thrown on the screen, and they simply have not thought of it in reference to a new standard of speed, but have accepted 60 as an approximate figure, and have gone ahead and obtained their effect by over- or under-cranking, just as they thought best.

It is really, in a way, silly to set an arbitrary standard, because we can see that every scene requires a different treatment, and the only thing we used the standard for is so that we will have something to measure our effect by, one way or another, and when we want to accelerate action, we slow our turning down; when we want to slow it up, we speed the turning up. Just changing from such a small percentage in the standard, when it is universally known that most motion picture projection is speeded up a certain percentage—it is a question one way or the other, and I don't think it is of a great deal of importance, as long as it is universally considered.

The Absorption of Light by Toned and Tinted Motion Picture Film

By Loyd A. Jones and C. W. Gibbs

The past few years have seen a remarkable increase in the use of toned and tinted motion picture film and a large proportion of the films made are colored by some process of toning or tinting. It is quite evident that since the production of color involves the absorption of certain components of the white light ordinarily used for projection purposes the screen brightness will in general be less when colored film is used. While the lower screen brightness may be desirable in the production of certain effects, it may be very objectionable in many cases and demand an increase in the current used in the projection lamp in order to produce a picture of satisfactory brightness. A knowledge of the absorption characteristics of the film colored by these various toning and tinting processes is of considerable practical importance, and it seemed desirable to make precise quantitative measurements of the amount of light absorbed by films colored in various ways. This communication is a report of the work done on the subject and consists of a description of the apparatus and method for the measurement of these values with considerable data relating to the absorption of light by samples prepared according to certain definite methods used in the toning and tinting of positive motion picture films.

The photographic deposit of which a picture is built up consists of minute particles of metallic silver embedded in a matrix of transparent gelatine. These deposits are of a diffusing nature, that is, the light transmitted by them is to a great extent deviated from its original direction of propagation and emerges from the film as scattered light. In specifying the transmission or density of such a deposit, it is, therefore, necessary to define carefully the conditions under which the measurement of these characteristics are made.

In the case of non-scattering media, the value of transmission is given by the ratio of the transmitted to the incident light intensity. Thus, if

I_0=intensity of incident light
I_1=intensity of the transmitted light
T=transmission

$$T = \frac{I_1}{I_0}$$

It has been found convenient in many cases to express the light stopping characteristics of a material in slightly different terms, this being especially true in the case of photographic deposits. For this purpose another term, namely, "density," is used and if

this be designated by the symbol D its value is defined by the equation

$$D = \log \frac{1}{T}$$

It has been shown experimentally in the case of photographic deposits consisting of particles of metallic silver embedded in gelatine that density is directly proportional to the mass of silver. Density values are additive quantities, that is, if two layers of known densities be superposed their combined density will be equal to the sum of the individual densities.

While values of transmission and density may be thus simply defined in the case of non-diffusing or non-scattering media, this is not true in the case of materials that scatter the light transmitted by them. The light transmitted by a diffusing media may be said to consist of two components:

(a) The "specular" component which is not deviated from its original direction of propagation by passing through the material.

(b) The "scatter" component which consists of light that has been deviated from its original direction of propagation by the material.

Since a photographic deposit is of a diffusing character, it is usual in speaking of the density or transmission of such deposits to qualify the terms by the adjectives "specular" or "diffuse," the former being applied to the value obtained by using the intensity of the "specular" component of the transmitted light, while the latter term applies to the value obtained considering both the "specular" and "diffuse" components as transmitted light. In practice, this latter value is usually obtained by illuminating the sample by completely diffused light such as may be obtained by placing the sample in contact with a piece of diffusing material such as pot opal glass. The value for specular transmission is measured in practice by placing the sample in a beam of parallel or collimated light in such a way that the transmitted intensity is that of the undeviated rays. It is evident in the case of a cinematograph picture being projected in the usual way that the scattered component of transmitted light is not useful as image forming light and that only the specular or image forming portion of the transmitted light is of interest. From a consideration of the optical characteristics of a motion picture projecting machine the density or transmission values of interest are thus almost identical with the "specular" values as defined above. The illumination on the film being projected, however, is not completely parallel and hence the effective value of transmission may be somewhat different than the true "specular" density. It seems advisable, therefore, in this particular case to measure what may be termed "projection" density or transmission which may be defined as follows:

If in a given projection assembly the screen brightness be measured with no film in position and this value be designated by

B_0 and the screen brightness again measured with the photographic deposit under consideration in position and designated by B_1, then the "projection" transmission T_P will be given by the relation

$$T_P = \frac{B_1}{B_0}$$

All of the transmission and density values given in this paper and applying to the various toned and tinted samples are computed in this way and are from the standpoint of projection the effective transmission and density values. Since many of the samples are highly colored the problem of determining the transmission is further complicated by the existence of color differences in the photometric field and in order to reduce the photometric errors to a minimum a flicker method was adopted. By this method the photometric field is alternately illuminated by the two lights which are to be compared and a means is provided whereby the frequency of alternation can be varied. In case the two lights being compared differ both in color and in intensity, a flicker due both to inequality of color and intensity will be present when the frequency of alternation is low. As this frequency is increased, however, a point is soon reached where the flicker due to color difference disappears owing to a blending of the two colors, while the brightness flicker persists. If, now, the frequency of alternation be maintained at a value just sufficient to eliminate color flicker, the residual flicker due to brightness difference may be eliminated by bringing the intensity of the two beams to equality. Since the field viewed is alternately illuminated by the two lights being compared and the frequency of alternation is sufficient to produce a blending of color, this field appears to be uniform in color and the criterion of photometric equality is the condition of no flicker, no flicker occurring when the intensity of the two beams is equal. In this way the necessity of judging the relative brightness of two fields differing widely in color may be avoided. The frequency at which the color flicker is eliminated depends both upon the magnitude of the hue and saturation differences and in practice if maximum precision is to be obtained the rate of alternation should be maintained at the critical frequency for the color difference under consideration. It is the general opinion among photomatricians that the flicker photometer provides the most reliable means of comparing the intensities of two lights differing widely in color.

Apparatus and Method

In Figure 1 is given a diagram showing the essential parts of the instrument constructed for this work. At *D* is mounted a Whitman disk which is driven by the motor *M*. Such a disk consists essentially of a circular plate from which alternate 90° sectors are cut away. The surface of this disk is covered with a matte white paper and is illuminated by the lamp *A* which is mounted on the carriage *O*. This carriage is moved back and forth by means of the steel tape *V* operating over the pullies *NN* and actuated by the

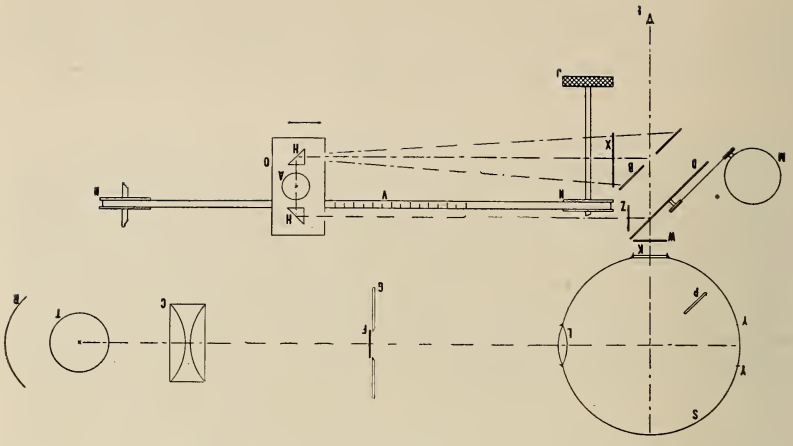


Fig. 1—Diagram of Integrating Flicker Photometer.

hand wheel *J*. The two total reflecting prisms *HH* are also mounted on the carriage *O* as shown, so that the Whitman disk *D* and the screen *B* are each illuminated to exactly the same extent regardless of the position of the carriage. Holders are provided so that neutral tint filters may be inserted at positions *W*, *Z*, and *X* as may be necessary.

The parts thus far described may be regarded as composing the flicker photometer proper while the parts indicated by the other elements of the diagram represent the special attachment for measuring the transmission of the film. Since it seemed desirable to measure the effect of various toning and tinting processes when applied to the finished positive film, it was necessary to adopt some method of integrating the light transmitted by the treated pictures. Such pictures consist of areas of widely varying density and in order to determine the mean or integrated value of transmission a small integrating sphere was used. This is represented by the circle *S* and consists of a copper sphere 12 inches in diameter in one side of which is mounted the lens *L* and at a point 90° from this the opal glass window *K*. The interior surface of this sphere is covered with a dead matte white enamel. A metal plate *G* serves as a support for the film being measured and in this plate a rectangular aperture of exactly the same dimensions as that in standard motion picture machines is cut.

The film to be measured is placed in position as indicated at *F*. A 250 watt stereopticon lamp *T* was used as a source for the illumination of the sample, a reflector *R* being used to increase the illumination on the aperture plate. The condenser *C* served to give to the illuminating beam the same convergence as is found in standard projecting machines. The lens *L* is of such focal length that a sharply defined image of the film *F* is formed on the interior wall of the sphere at *YY*, the magnification being two diameters. A small

opaque disk P is placed in position as shown and serves to shield the opal glass window. K from the direct illumination from the picture area YY. The photometric field is observed from the point E as indicated and consists of a circular area, the outer portion of which is formed by the screen B, while the inner portion termed the "flicker field" is illuminated alternately by light reflected from the Whitman disk D and by that transmitted by the opal glass window K. A photometric setting is made by adjusting the position of lamp A to such a point that flicker is eliminated from the inner portion of the field, this being the condition under which the brightness of the disk surface is equal to that of the opal glass. In this particular instrument a brightness balance between the outer and inner portion of the field also exists at the no-flicker setting. It is thought that the use of a surrounding field of the same brightness tends to increase the sensitivity of the flicker method since the observer at all times has in the field of vision a non-flickering area which tends to increase his sensitivity to flicker in the inner part of the field. This point has not as yet been definitely verified but it has been found that readings can be repeated with great precision with this instrument. The comparison lamp A and the illuminating lamp T are run under constant conditions by means of suitable rheostats and indicating instruments. In practice it was found most convenient to calibrate the instrument in terms of the density of the film placed at F. In order to increase the scale of the instrument the multiplying filters must be used at positions W and Z, these also are carefully calibrated in terms of density. From the calibration curve plotted with density values as ordinates and scale readings as abscissae, the density of any film placed at F can be read directly and in case transmission

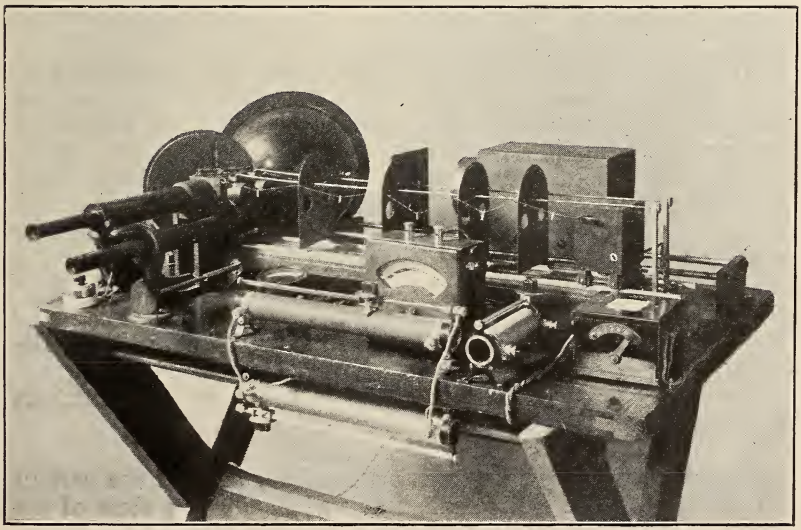


Fig. 2—Integrating Flicker Photometer, (Front View).

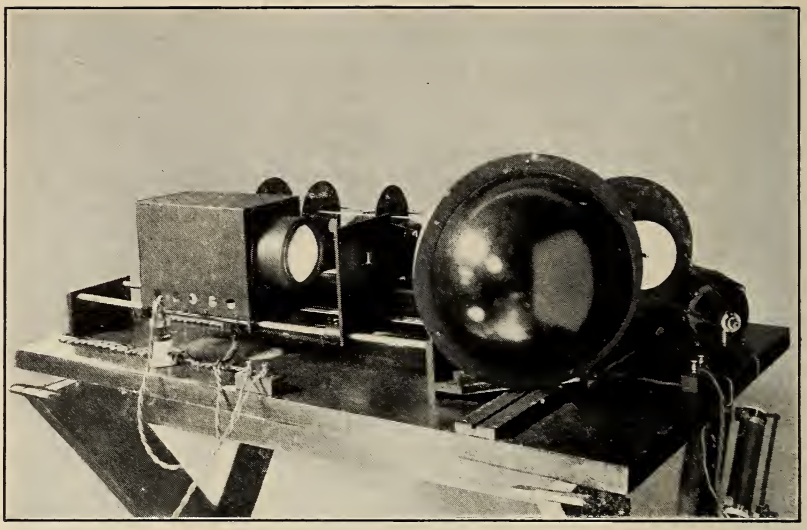


Fig. 3—Integrating Flicker Photometer, (Rear View).

values are desired they can be read directly from suitable conversion tables.

Photographs of the complete instrument as assembled are shown in Figures 2 and 3.

The methods of coloring positive film may for the purpose of this discussion be divided into three classes, namely:

a. Dye tinting.
b. Dye toning.
c. Chemical toning.

A detailed discussion of the methods employed in the dye tinting of film has been presented before this society at a previous meeting by Mr. G. A. Blair, and is published in Vol. 10, page 45 of the Transactions of this Society. By this method the color is obtained by immersing the finished positive in a solution of dye which colors the gelatine, thus giving a uniform color to all parts of the picture. A complete discussion of the various processes of dye toning and chemical toning will be found in a booklet entitled "The Tinting and Toning of Eastman Positive Motion Picture Film," published by the Eastman Kodak Company. An article dealing with the subject was published in the Motion Picture News, p. 3255, December, 1918.

The results obtained with samples treated by these various methods will, for the sake of convenience, be treated separately.

Transmission of Dye Tinted Samples

Three types of samples were prepared for each of the various tints examined. The first sample consisted simply of a piece of unexposed, fixed-out posisitive film which was subjected to the action of the dye bath for a time sufficient to give the desired color. Since

it is possible that the presence of the silver image may have some influence on the behavior of the tinting process, the effect produced when the process is applied to a picture consisting of such deposits may be somewhat different from that indicated by the measurement of the fixed-out sample. A typical negative of what was judged to be average quality (from the standpoint of contract and relative proportion of highlight and shadow region) was chosen and a considerable length of positive printed from a single negative and developed in the usual way giving a normal positive consisting of a large number of identical pictures. In order to illustrate the general nature of the subject chosen, this positive is reproduced as Picture No. 41, in Figure 8 of this communication. Short lengths of this positive were cut and dyed along with the unexposed fixed-out samples, the two receiving identical treatment in the tinting bath.

In order to study still further the effect of photographic density on the result, a sensitometric strip consisting of areas of increasing density were also prepared. These strips were made on ordinary cine positive film and each area of uniform density was of the same size as a standard cinematograph picture and therefore filled completely the aperture in the film holder of the photometer previously described. The minimum density was practically equivalent to the fog density of the material while the maximum density was approximately 2.8, thus including the entire density range ordinarily used in the production of positives. One of these sensitometric strips was treated along with the two samples previously described, the dye treatment for the three samples being identical. All tests were run in triplicate so that the values reported are in all cases the mean of three independent determinations. The various formulae used for the tinting of the samples examined are given at the end of this communication.

In Table 1 are given the numerical results obtained with the various samples of tinted film. Under the section marked "Plain

TABLE No. 1

TRANSMISSION OF TINTED FILM

Sample	*Name*	*Plain Film*			*Picture*		
		D	T	T^r	D	T	T^r
0	Untinted	.055	88	100	.84	14.5	100
2	Cine Red (A)	.41	39	44	1.18	6.6	45
1	Cine Red (B)	.43	37	42	1.20	6.3	43
3	Cine Scarlet (A)	.36	44	50	1.13	7.4	51
4	Cine Scarlet (B)	.66	22	25	1.43	3.7	25
7	Cine Orange (A)	.20	63	72	.99	10.0	69
8	Cine Orange (B)	.25	56	64	1.01	9.7	66
5	Cine Yellow (A)	.16	68	77	.92	11.9	82
6	Cine Yellow (B)	.15	71	80	.95	11.2	77
29	Cine Green No. 1 (A)	.18	66	75	.98	10.5	72
28	Cine Green No. 1 (B)	.45	36	41	1.19	6.4	44
31	Cine Green No. 2 (A)	.25	56	64	1.05	9.0	62
30	Cine Green No. 2 (B)	.61	24	27	1.34	4.6	32
26	Cine Blue (A)	.65	22	25	1.44	3.6	25
27	Cine Blue (B)	.81	16	18	1.54	2.9	20
33	Cine Violet (A)	.62	24	27	1.33	4.7	32
32	Cine Violet (B)	.63	23	26	1.43	3.7	26

Film" are those applying to the unexposed, fixed-out samples, the values in Column *D* being those of "Density," in Column *T*, those of transmission, and in Column *Tr* the relative transmission values referred to the transmission of the untinted samples as 100%. Under the section marked "Picture" are the corresponding values relating to the pictures tinted according to the various processes. The *A* and *B* variations are obtained by changing somewhat the time of dyeing so as to obtain variations in the resultant tint, the "A" tint in each case being the lighter, that is, having the higher transmission.

Measurements on the sensitometric strips show that in general the absorption of the dye is practically independent of the density although in the case of cine yellow and cine orange there is indication that the highlight region absorbs slightly more dye than the shadow regions, that is, regions of high density. This tends to produce a slight decrease in the contrast and hence produces a slight

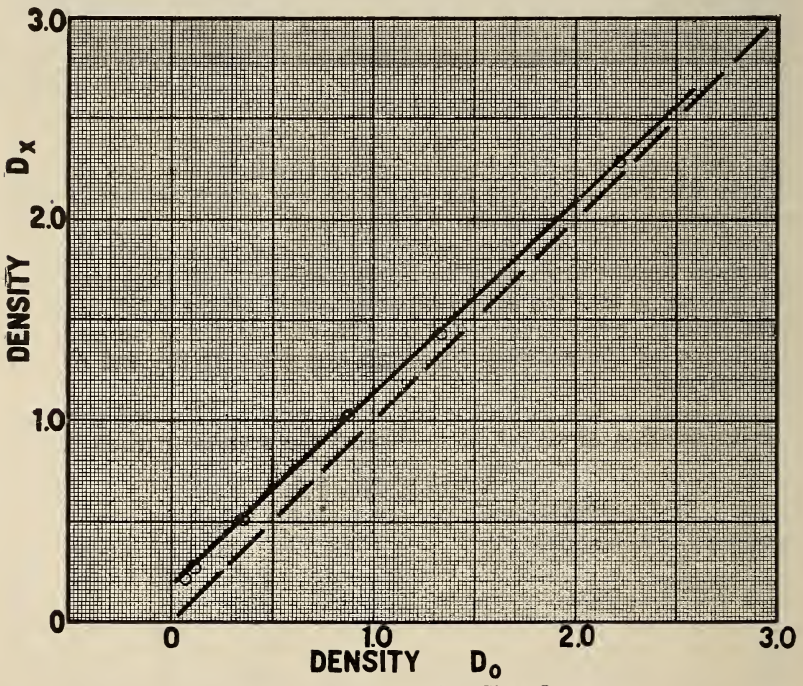


Fig. 4—Density Curve for Cine Orange.

flattening of the picture. The effect, however, is not large and does not manifest itself in the case of all tints. The results of the measurements of the sensitometric strips treated with the cine orange are shown graphically in Figure 4, the density values of various areas of the tinted sensitometric strip being plotted against the density values of the corresponding areas of the untinted strips. The points indicated by the small circles represent the results of the measure-

ments plotted in this way. A line at 45° to the X axis and passing through zero represents the line of no density change owing to the tinting. It will be noted that the curve obtained is not precisely parallel to this 45° line, thus indicating that the areas of low density have suffered a greater proportional density increase than those of higher density.

In Figure 5 are shown the results obtained on samples 30 and

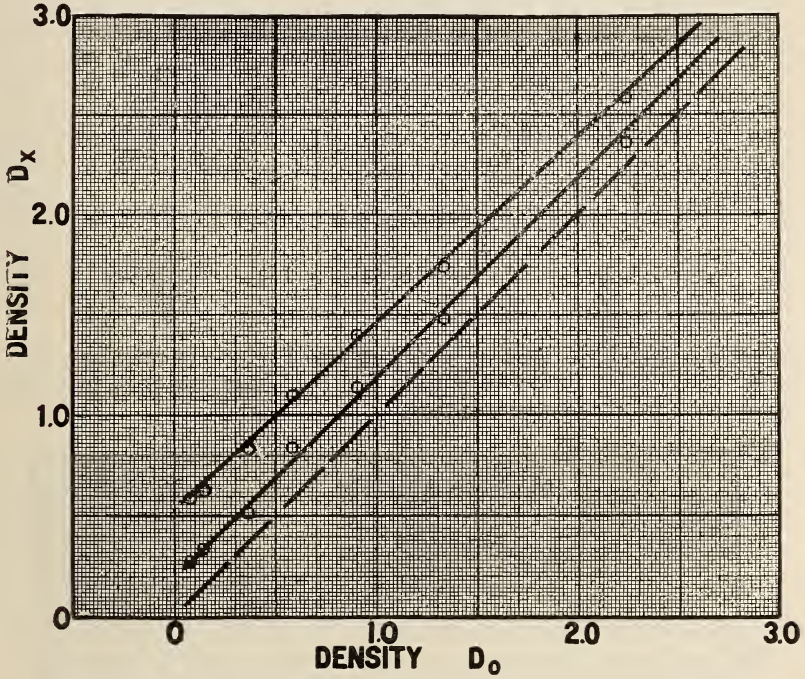


Fig. 5—Density Curves for Cine Green.

31, namely, Cine Green No. 2 (A) and (B). In this case it will be noted that the curves are to within the errors of measurements straight lines parallel to the line at 45° to the X axis, indicating that in this case no measurable change in the photographic quality other than the uniform increase in density has resulted from the action of the tinting dye. The curves shown in Figures 4 and 5 are typical of those obtained on all of the samples thus far examined, the cine orange and cine yellow samples behaving as shown in Figure 4 while all other tints appear to behave as shown in Figure 5.

Transmission of Dye Toned Samples

In coloring film by this process, the positive is bleached in a suitable bath and then immersed in a solution of the dye being used. This dye is mordanted to the image thus producing the dye tone. Samples were prepared in exactly the same way as for the dye tinting process, an unexposed, fixed-out sample, a normal picture, and

a sensitometric strip being prepared in each case, and all tests run in triplicate. The results obtained with the fixed-out sample and the picture are given in Table 2. It will be noted that the transmission of the unexposed, fixed-out samples is uniformly high for all samples. This is typical of this process since very little mordanting of the dye occurs except where there is a bleached silver image. Since these samples were unexposed, the only silver present was

TABLE No. 2

TRANSMISSION OF DYE-TONED FILM

Sample	*Name*	*Plain Film*			*Picture*		
		D	T	T^r	D	T	T^r
0	Untoned	.055	88	100	.84	14.5	100
9	Bismark Brown	.17	67	76	.96	10.9	75
12	Malachite Green (A).....	.16	69	78	1.10	8.0	55
10	Malachite Green (B).....	.17	67	76	1.12	7.6	52
11	Malachite Green (C).....	.18	66	75	1.15	7.0	48
15	Safranine (A)	.18	66	75	1.00	10.0	69
14	Safranine (B)	.18	66	75	1.03	9.0	62
13	Safranine (C)	.18	66	75	1.20	6.3	43
18	Auramine (A)	.15	71	81	.86	14.0	96
17	Auramine (B)	.16	69	78	.90	13.0	89
16	Auramine (C)	.16	69	78	.93	12.0	83

that due to the inherent fog of the material which is relatively low so that in these samples very little bleached image is present upon which the dye may be mordanted.

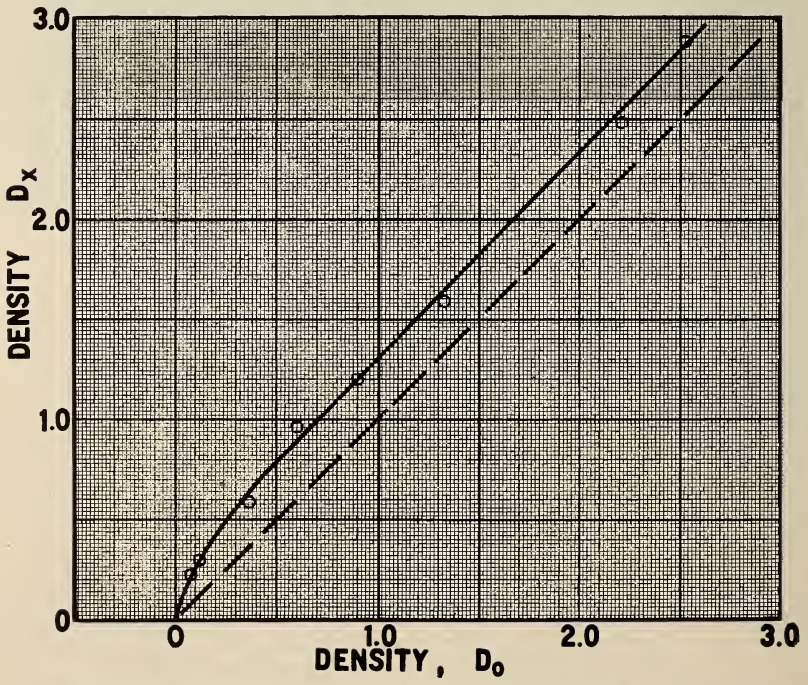


Fig. 6—Density Curve for Malachite Green (Dye Tone).

In Figure 6 are shown the measurements obtained on one of the sensitometric strips dye toned with Malachite Green. It will be noted that in the region of higher densities that the curve is parallel to the 45° line, thus indicating that in this region the increase in density is independent of the original density, but in the regions of lower density this is not the case as is indicated by the curve in Figure 6. The highlight regions, therefore, suffer less intensification than the shadows and darker half-tones. It is evident that such action results in increased contrast in the dye toned positive. The results illustrated in Figure 6 are typical of the other dye-toned sensitometric strips that have been examined thus far.

Transmission of Chemically Toned Samples

Complete discussion of the methods for obtaining these chemical tones have been referred to earlier in this communication and no attempt will be made at this time to specify the exact processes by which the samples examined were prepared.

Detailed directions may be found in the booklet referred to or in the Motion Picture News as follows:

Sulphide,	Tone F,	page 3580, 1918.
Iron,	Tone H,	page 3580, 1918.
Uranium,	Tone B,	page 3411, 1918.

The variants *A, B,* and *C* were obtained by changing the times of toning.

The results obtained with the unexposed, fixed-out sample and the normal picture are given in Table 3, the values of the various columns being analogous to those in the previous tables. It will be noted in this case also that the transmission of the unexposed fixed-out sample is in all cases very high approaching in some cases that

TABLE No. 3

CHEMICALLY TONED FILM

Sample	*Name*	*Plain Film*			*Picture*		
		D	T	T^r	D	T	T^r
0	Untoned	.055	88	100	.84	14.5	100
19	Sulphide	.14	72	82	1.00	10.0	69
22	Iron	.09	81	92	1.04	9.1	63
21	Iron	.09	81	92	1.15	7.1	49
20	Iron	.10	79	90	1.17	6.7	46
24	Uranium	.14	72	82	1.01	9.8	68
25	Uranium	.15	71	81	1.07	8.5	59
23	Uranium	.15	71	81	1.17	6.7	46

of the untoned sample. In the case of this method the coloring is very slight in those regions of low photographic density, the effect increasing as the amount of silver present increases. The transmission values of the normal picture, it will be noted, are in general somewhat low, this indicating that films prepared by this method will in general be of high density and require a considerable increase in the intensity of the projecting light in order to produce pictures of normal brilliancy.

In Figure 7 are shown graphically the results of the measurements obtained on one of the sensitometric strips toned by the iron process. In this case the lack of proportionality in the increase of

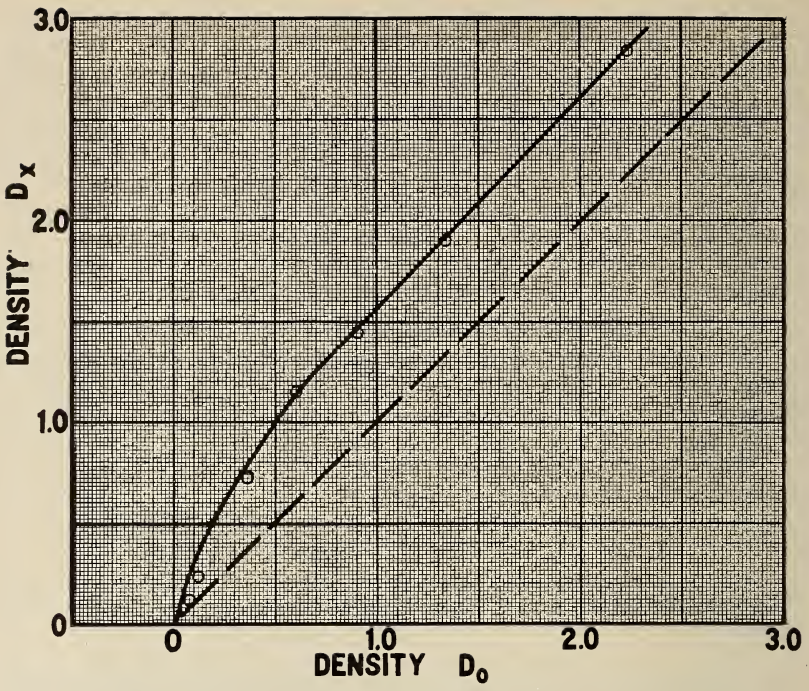


Fig. 7—Density Curve for Iron Tone (Chemical Tone).

density is even more marked than in the case of the dye toning process shown in Figure 6. It will be noted that there is a very slight increase in the density of the highlight region while the increase in density in the case of the higher densities is very marked. Here again the curve for the region between densities of .6 and 2.6 is practically parallel to the 45° line showing that in this region intensification is proportional, while for densities of less than .6 this is not true. Such an action of the chemical toning process produces a marked increase in the contrast of the positive and undoubtedly results in a considerable change in photographic quality of the pictures thus treated. The behavior as illustrated by the curve in Figure 7 is typical of all of the toning chemical processes thus far examined.

Mean Transmission of Cinematograph Positives

The question has frequently been raised as to the average transmission of various types of cinematograph positives. Since it is quite easy with the apparatus developed for the study of toned and tinted film to measure the mean or average transmission of such films, it was decided to select a group covering the entire range of subjects as completely as possible and to measure the mean transmission of these films. From a stock of positives 41 different pictures were chosen and the mean transmission values of each determined. In Table No. 4 are given the results of each measure-

TABLE No. 4

AVERAGE TRANSMISSION OF MOTION PICTURE FILMS

Sample	T	Sample	T
1	19.46%	22	16.65%
2	21.35	23	16.65
3	10.18	24	4.14
4	22.34	25	10.00
5	7.75	26	10.18
6	4.36	27	7.20
7	26.87	28	14.60
8	17.33	29	3.24
9	18.19	30	11.99
10	7.40	31	14.50
11	22.34	32	19.09
12	7.20	33	14.60
13	4.36	34	37.90
14	8.12	35	20.80
15	8.30	36	20.80
16	4.06	37	9.11
17	30.90	38	10.93
18	7.08	39	38.85
19	14.60	40	16.65
20	14.50	41	14.50
21	5.76		

Average Transmission 14.50%
High Transmission (No. 39).....38.8 %
Low Transmission (No. 29)..... 3.2 %

ment and it will be noted that the highest transmission is 38.8%, while the lowest is 3.2%, the mean of the 41 being 14.5%. It is interesting to note the coincidence occurring between the mean of this group and the particular picture chosen for making the toned and tinted samples. In order to convey a more concrete idea as to the mean transmission of various types of subjects, 12 of these are reproduced in Figures 8 and 9. Below each picture is the identification number with the mean transmission value for the positive. We are indebted to Mr. Thomas H. Ince and to the Goldwyn Corporation for the original negatives from which these illustrations are made.

Summary

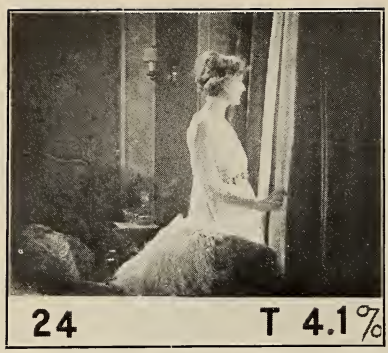
An instrument suitable for the measurement of the transmission of toned and tinted motion picture film has been designed and constructed, and a satisfactory method for the measurement of the desired values worked out.

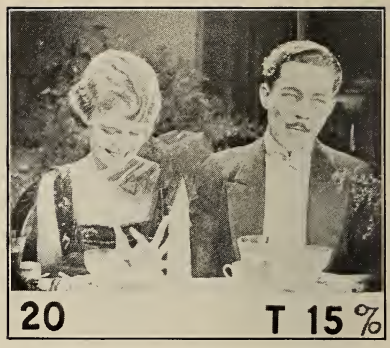
A large number of samples of toned and tinted film have been prepared and their transmission determined.

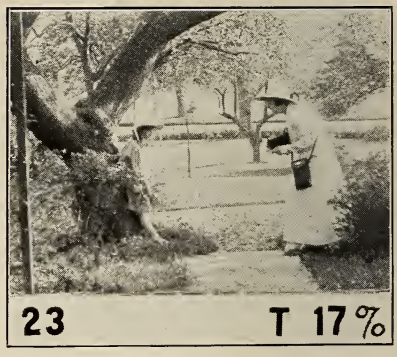
Results indicate that in the case of dye tinting no appreciable change in the photographic quality is produced and while the transmission may vary over a wide range depending upon the precise treatment that in general the transmission is fairly high.

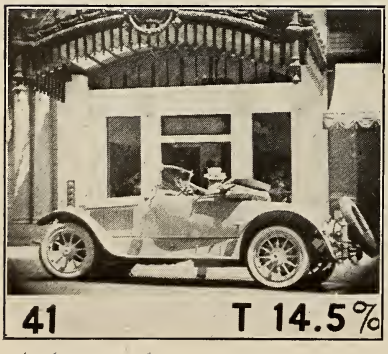
The various processes of dye toning in general produce a slight distortion in the photographic quality, this being in the direction of increasing the contrast especially in the region of the lighter halftones.

Chemical toning processes also tend to produce some change in photographic quality, this also being in the direction of enhanced contrast.









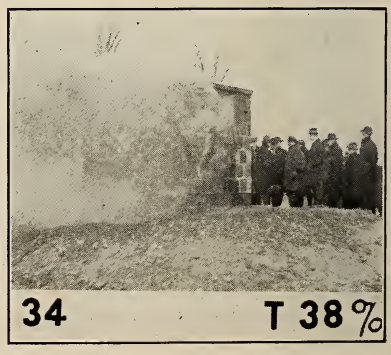
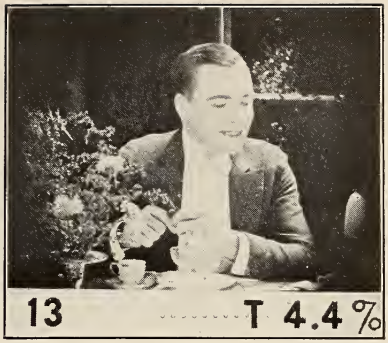
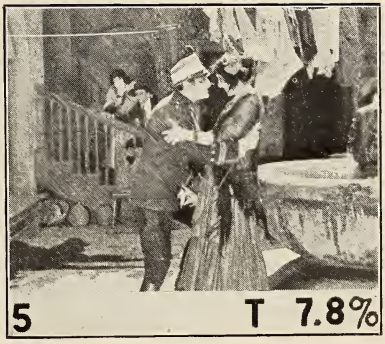


Fig. 8—Typical Cine Pictures (With values of average transmission).





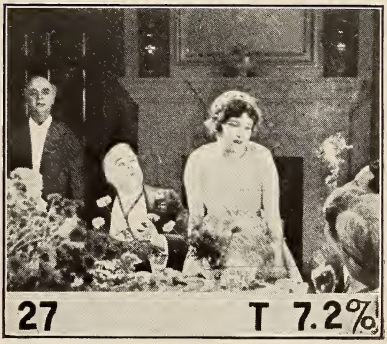


Fig. 9—Typical Cine Pictures (With values of average transmission).

The mean transmission of a representative group of positives has been measured and the average found to be 14.5%.

The authors wish to acknowledge their indebtedness to Mr. J. I. Crabtree for his co-operation in this work, and to Mr. Delos Rupert who prepared all of the toned and tinted samples upon which measurements were made.

Rochester, N. Y., April 2, 1921.

FORMULAE FOR TINTING

In preparing the tinted samples the following dyes were used, the figures given being the amounts of the various dyes per 200 liters of water.

Tint	*Amount*	*Name of Dye and Manufacturer*
Cine Red	250 grams	Amaranth (H. A. Metz & Co., N. Y.)
Cine Scarlet	250 grams	Crocein Scarlet MOO (National Aniline & Chemical Co., N. Y.)
Cine Orange	250 grams	Wool Orange GG (National Aniline & Chemical Co., N. Y.)
Cine Yellow	250 grams	Wool Yellow Extra Conc. (National Aniline & Chemical Co., N. Y.)
Cine Green No. 1	400 grams	Acid Green L (National Aniline & Chemical Co., N. Y.)
Cine Green No. 2	400 grams	Naphthol Green B Conc. White Tar Aniline Corp., 56 Vesey St., N. Y.
Cine Blue	250 grams	Direct Blue 5B Essex Aniline Works, 39 Oliver St., Boston, Mass.
Cine Violet	250 grams	Fast Wool Violet B (National Aniline & Chemical Co., N. Y.)

Communication No. 122 from the Research Laboratory of the Eastman Kodak Company.

Discussion of Paper Entitled "Transmission of Tinted Motion Picture Films"

By L. A. Jones

A Member: With regard to this chemical tinting, would you advise the under-exposing of prints to get better results, Mr. Jones?

Mr. Jones: No, I didn't intend to convey that impression. Chemical toning will not create details which are not present in the untoned positive. The prints should be normally exposed and by normal exposure it is usually understood that a just perceptible density is obtained in the positive through the highest density of the negative. This means that the highlight of the picture is represented by a practically clear film, and it also means that the high-light region is rendered on the toe of the characteristic curve of the positive material. The chemical toning of such positives tends to straighten out this portion of the curve and to improve the tone reproduction, but if the print to be toned is unexposed this cannot be corrected by chemical toning.

Mr. Richardson: Have you made any experiments with discolored condensers?

Tests I have made and other tests which have been made for me by one of the lamp company's laboratories have proven that where, by reason of discoloration of the glass, there is an apparent depreciation of as much as fifty percent in screen brilliancy. A photometer shows the depreciation in light flux to be not exceeding eight or nine per cent.

Wouldn't that hold true? Isn't there such a thing as a photometer reading that is very unconvincing when you apply it to the actual disability of the eyes?

Mr. Jones: You are quite correct. At the present time the word "brightness" is commonly used as a name for two different factors; namely, "objective brightness" and "subjective brightness," the former being a function of the physical factors while the latter includes not only the physical factors but physiological or psychological factors relating to the condition of the observer's retina. For instance, consider a surface such as a sheet of paper subjected to a certain illumination. Its objective brightness is the same regardless of the surroundings or the conditions under which it is viewed, that is, its objective brightness is dependent only upon the illumination. If this same surface is observed out-of-doors under natural conditions with the eye adapted to full sunlight, the subjective brightness may be relative low while if observed in a completely darkened room the subjective brightness may be very high. It appears desirable to adopt different words to represent these factors. The word "brightness" has already been defined by the Illuminating Engineering Society as the objective brightness. The Optical Society of America is at the present time working on standardization of color nomenclature and the word "brilliance" has been proposed for use in signifying subjective brightness. This proposition seems to be quite satisfactory since the term brilliance has not been officially defined or adopted to represent anything else.

Dr. Story: I would like to suggest that a good many authors have used the words "objective brightness" to determine the appearance of the projection of subjective brightness, instead of the word "brilliance."

That has been used by a number of men already. I would like to suggest that to Mr. Jones as a possible substitute.

Mr. Jones: It strikes me that the use of the term "objective brightness" to signify what I have just defined as subjective brightness is very objectionable. It seems to me that the term is self-contradictory.

Mr. Richardson: You would hold "brightness" and "apparent brightness" to be all right?

Mr. Jones: The use of the term brightness and apparent brightness is fairly satisfactory although I prefer to use a single word such as brilliance instead of the two term expression. Of course, it is merely a question of terminology and provided the majority of those interested agree upon a definition and are consistent in using it in the sense indicated almost any term will be found satisfactory. As stated previously, the word brightness has already been defined and it strikes me that the use of brilliance in the case of subjective brightness would be very satisfactory, much more so than using two words in each case such as subjective brightness and objective brightness.

Mr. Richardson: I have used "brightness" to represent the photometer readings, and "apparent brightness," to represent it as it appears to the eye.

Dr. Story: May I just say one more word in defense of my attitude? I did not mean objective brightness was the actual brilliancy, the physical brilliancy. There are three terms; the physical brightness, which is an essential of the object itself.

Mr. Jones: Expressible in what?

Dr. Story: Expressible in luminance—which is a physical thing purely. There is subjective brightness, which is the impression the eye obtains from that physical stimulus, which is a question of the adaptation level and the size of rectilineage, and so on, and then we have the objective brightness, which is the effect of that subjective impression. It is simply a question of terms and definition.

Mr. Jones: I agree that it is largely a question of agreeing on terminology, but even so I think our terminology should be as logical and coincide as nearly as possible with our commonly accepted definition of words. I must confess I do not follow Dr. Story's reasoning and feel that perhaps it is a question of philosophy rather than physics.

Dr. Gage: As a matter of information I would like to ask Dr. Jones whether the result of tinting is not exactly the same as though a separate color screen were placed in the optical system and, therefore, the effect of the straight dye-tinting, as distinguished from dye-toning, could be studied with separate filters.

Dr. Jones: Our results indicate that the dye tinting of film produces exactly the same result on the screen as can be obtained by projecting through a color filter. Previous to this work we were not

certain that this was the case. It was believed by some that the absorption of the dye was dependent upon the density of the silver image. Had this been proved the result would not have been the same as placing a color screen over the projection lens, the dye tinting would change the photographic quality of the projected picture. Our results indicate that dye tinting is equivalent to placing the color filter in the path of a projected beam and therefore we can now study the effect of film tinting by such a screen method.

Dr. Story: Dr. Jones was kind enough to furnish the Optics Committee with the films they used in its recent color tests. The Committee found in the tests on those films, that apparently there was a greater contrast in the tinted film than there was in the untinted film. The concentration of dye around the silver particles given as a possible reason for this, as I understand now, this explanation is refuted by your tests?

Yes, apparently that is disproven. I think we will be forced to look elsewhere for an explanation of the facts mentioned by Dr. Story, and I think it is quite possible to explain the results as due to subjective factors. We did not take up this point in the paper and do not consider it advisable to discuss it at this time.

Mr. Mayer: Just after Dr. Jones finished his paper I took the opportunity to speak to him on the subject. I don't know whether he cares to mention the thing, but I think the members would be interested in knowing that at the present time there is available on the market a raw film positive stock pre-tinted in its base, so that the tint color is standard for all shades. The same shade is available for all like scenes. If it is an orange, the same orange is available at all times, and it eliminates the personal element of the individual operator in the laboratory who does the tinting, the strength of the bath, and the period of time he leaves it in, which causes a considerable variation.

In using the pre-tinted raw film stock the color is already in the film and the print is made thereon and subsequently developed. From what Mr. Jones has told me, the Eastman Company is at the present time preparing similar stock which I believe they contemplate marketing in the near future. The stock on the market at the present time is of French make and used at the Coast considerably. I thought there might be some interest in that, if Mr. Jones is disposed to discuss it.

Mr. Richardson: You don't mean they are incorporating it in the celluloid stock?

Mr. Mayer: Yes, in all colors.

Dr. Jones: I do not wish to make any official statement on this subject. However, the tinted base has been manufactured by foreign firms for some time and we have received and examined samples of this material from several sources, French, German, and Belgian. It strikes me that it is the logical way to handle the tinting proposition. As far as I can see there is no reason why the dye can not be placed in the base by the film manufacturer, and I rather think that this will be the solution of the tinted film proposition.

Condenser Lenses for Theater Motion Picture Equipments

Carl E. Egeler

With the development of the Mazda lamp for motion picture projection the limitation formerly imposed in source-condenser spacing due to heating and fouling was obviated. Attempts were at once made to design condenser lenses of shorter focal length and capable of intercepting a larger percentage of the light from the source. A successful solution was the prismatic condenser, a special form of Fresnel lens, which includes a relatively large angle without excessive aberration.

With a lens of this design, however, there results a considerable loss of light deflected by the risers of the prisms. The light issues from the lens not as a solid cone, as from the plano-convex condenser, but in several concentric cones, one from each of the prisms and from the center double-convex section. This property is both an advantage and a disadvantage. A slide placed close to the condenser would obviously not be satisfactorily illuminated and thus in those small theaters in which separate stereopticon equipments are not installed, a plano-convex condenser must be added for slide projection, and provision made for moving the lamp. The great advantage involves the characteristics of the light source. The filament coils of the incandescent lamp do not present source area of uniform brightness. With the plano-convex condenser some unevenness in the beam remains at the aperture, but with the several rings of the prismatic condenser the source is focused at different distances along the axis and the images are so superimposed that the beam is made practically uniform where it passes through the aperture. A further loss of light results thereby, inasmuch as a relatively greater amount falls outside of the aperture limits.

The actual relative net results in screen illumination with the two types of condenser lenses have, so far as we are aware, never heretofore been completely ascertained and stated. General conclusions have been drawn from observation with a limited range of sizes, focal lengths, and spacings of the optical elements. Experiences by other individuals under somewhat different conditions did not seem to check these general conclusions and there has been a distinct feeling of uncertainty in the minds of many as to the exact facts. In order to contribute to a clarification of this situation, a comprehensive investigation was undertaken of total light flux projected to the screen, its distribution, amount of aberration, and required precision of adjustment with the commercial plano-convex and prismatic condenser lenses.

For the purpose of this investigation the light source form and dimensions, mirrored reflector, condenser diameter, and aperture were

considered as constant from a commercial standpoint. The light flux projected and evenness of screen illumination are then dependent on the following variables:

Condenser focal length,
Source-condenser distance,
Condenser-aperture distance,
Mirrored reflector adjustment,
Projection objective diameter,
Projection objective working distance (back focus).

In these tests the condensers and objectives included below were employed:

Plano-convex spherical condensers, 4½-inch diameter—
6½ and 6½-inch foci,
6½ and 7½-inch foci (6½-inch lens adajcent to lamp).
7½ and 7½-inch foci.

Prismatic condensers, $4\ \frac{7}{16}$-inch diameter—
2½ and 6½-inch rated working distances.

Projection objective lenses—
No. 1 (quarter size) of 3⅝, 4, 5½ and 7½ inches equivalent foci.
No. 2 (half size) of 5½ and 7½ inches equivalent foci.

Spherical mirrored reflector, 5¼-inch dimeter, 3½ inches outside radius of curvature.

Standard aperture, 0.680 by 0.906 inches.

Mazda C lamps, 30-ampere, 28-32 volt, T-20 bulb, monoplane filament, 0.43 inches wide and 0.5 inches high.

A number of condensers and objectives were measured for light transmission and the several units used were selected as representative of the good commercial product. The plano-convex condensers showed transmissions of from 88.3 to 89.9 per cent for each lens of the combination; they were imported ground lenses and were free from any marked yellowish tint. The prismatic condensers showed a similar uniformity. The transmissions of the objectives were about 71.5 and 68 per cent for the No. 1 and No. 2 sizes respectively.

The lamps were checked at intervals throughout the tests to insure constant candlepower.

Total light flux and screen illumination data were obtained with a Weber photometer, whose calibration was checked periodically.

TEST PROCEDURE

Plano-Convex Condensers

Using the plano-convex condensers, the aperture-condenser and condenser-source spacings were varied independently for each objective and the appearance of the screen was recorded, using the nomenclature given in Table 1. The degree of unevenness of illumination considered as permissible and denoted by the letter A was just less than that which

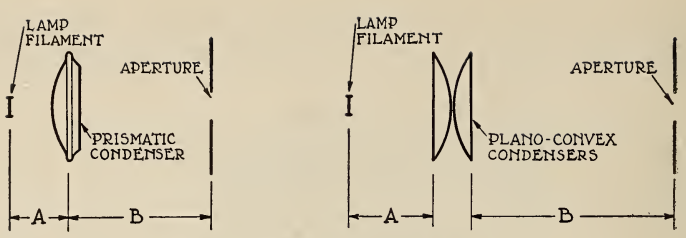


Fig. 1—Working Distances for Prismatic and Plano-Convex Condensers

would be detected during the projection of light density film, such as animated cartoons. The designation AA was applied to the most even illumination as revealed on close inspection without film.

TABLE I

NOMENCLATURE FOR SCREEN APPEARANCE

AA	Good even screen.
A	Slightly uneven screen but satisfactory for projection purposes.
B	Rings barely noticeable.
C	Bad rings or spots noticeable with a clear film.
D	Vertical or horizontal streaks barely noticeable.
E	Bad streaks noticeable with clear film.
F	Noticeable color, edge or corners.
G	Bad color.

Parentheses denote results with mirrored reflector.

Asterisks denote screen appearance not suitable for motion pictures.

With several fixed aperture-condenser distances within the practicable range the source was moved back from the condenser until a maximum permissible unevenness of screen was obtained. With increased distance between source and condenser, the screen illumination became more uneven; the maximum spacing for permissible unevenness was noted as indicated in Table 2. The total light flux directed to the screen was measured for each of these limiting settings and for such further points as was necessary to determine whether the settings corresponded to maximum screen illumination. Measurements of the illumination at sixteen points over the screen area were then made for these same settings so that the visual impression might be checked against quantitative data. The above procedure was followed through both for lamp alone and lamp with reflector. The mirrored reflector was in general set by observing the reflected image of the source projected by the condenser and objective on a card placed in front of the objective lens; in some cases it was necessary to place the card behind the objective in order to intercept a well-defined image.

TABLE 2—TYPICAL VISUAL TEST DATA FOR SCREEN APPEARANCE
No. 2, 7½" E. F. Projection Objective
4½-inch diameter, 6½"-6½" plano-convex
condenser combination

Aperture-Condenser Distance Inches	Source-Condenser Distance Inches	Appearance of Screen
7	2	AA(AA)
7	3	A*(AA)
7	3½	E*(AA)
7	3¾	E*(A*)
8	2	AA(AA)
8	3	E*(AA)
8	3½	E*(A)
8	3¾	E*(A*)
9	2	AA(AA)
9	3	E*(AA)
9	3¼	E*(A)
9	3½	E*(A*)
10	2	A(AA)
10	3	E*(A)
10	3¼	F*(A)
10	3½	G*(A*
11	2	A*(AA)
11	2¾	E*(A)
11	3	E*(A)
11	3¼	G*(A*)

Parentheses denote results with reflector.
Asterisks denote screen evenness unsatisfactory for theater projection.

Table 3 indicates the large loss in screen lumens when the source-condenser distance is decreased below that value at which usable evenness is obtained, due to the size of the beam at the aperture increasing at such a rate that a smaller percentage of the larger amount of light intercepted by the condenser passes through the aperture.

This procedure was followed through for the several equivalent foci objectives of both No. 1 and No. 2 sizes.

TABLE 3—REPRESENTATIVE VARIATION IN SCREEN LUMENS WITH CHANGE IN SOURCE-CONDENSER DISTANCES FOR CONSTANT CONDENSER-APERTURE DISTANCE.

Aperture-Condenser Distance Inches	Source-Condenser Distance Inches	Lumens
6	5	372
6	4	182
7	4½	432
7	4	316

Prismatic Condensers

The tests conducted with the prismatic condenser covered similar observations for the specified source-condenser and condenser-aperture distances and sufficient others to obtain total flux and evenness of

TABLE 4—VARIATION OF LIGHT FLUX AND SCREEN APPEARANCE WITH CHANGE IN OPERATING DISTANCE FOR PRISMATIC CONDENSER.

5½-inch E. F. No. 2 Objective Lens—30-ampere 28-32 volt Lamp Without Reflector

Aperture-Condenser Spacing Inches	Condenser-Source Spacing Inches	Lumens on Screen Bare Lamp	Appearance of Screen	
			Bare	Mirror
6½	2¼	363	AA	(AA)
6½	2⅜	432	A	(AA)
6½	2½	468	E*	(AA)
6½	2⅝	480	E*	(A)
6½	2¾	473	E*	(E*)
6½	2⅞	445	E*	(E*)
4	2½	417	AA	(AA)
5	2½	463	A	(AA)
5½	2½	463	D	(AA)
6	2½	467	D	(AA)
6½	2½	469	E*	(AA)
6¾	2½	468	E*	(AA)
7	2½	465	E*	(A)
7½	2½	454	E*	(A)
5	2⅝	477	E*	(AA)
5	2¾	498	E*	(A)
5½	2⅝	445	E*	(AA)
5½	2¾	498	E*	(A)
6	2⅝	492	E*	(A)
6	2¾	490	E*	(E*)
7	2⅝	465	E*	(A)
7	2¾	448	E*	(D)
7½	2⅝	442	E*	(D)
7½	2¾	418	E*	(E*)

* Screen evenness not satisfactory for theater projection.

illumination data on the effect of changing either distance independently, or both. Table 4 and the curves of Fig. 2 show the range of operating distances employed. In Table 4 the screen lumen values are given for the lamp without reflector, since the average increase due to the mirror bears a practically constant relation to the bare lamp values.

Plano-Convex Condenser With Slide Holder

The loss of light through the motion picture optical system due to use of a slide holder was obtained by measurement of the screen lumens for slide holder positions adjacent to and one inch in front of the plano-convex condenser lens, which are the usual limiting conditions for the projection of large slides with 4½-inch diameter condensers, and for the same optical system without slide holder.

Objective Lenses

The objective lenses were tested not only for light transmission, but the definition, aberrations, and image distortions were observed by the projection of special line gratings placed at the aperture.

SUMMARY OF RESULTS

A summary of the test data is given in Table 5. Inspection of these data shows that in making a selection of the best operating distances for the plano-convex condensers, for many objectives there is

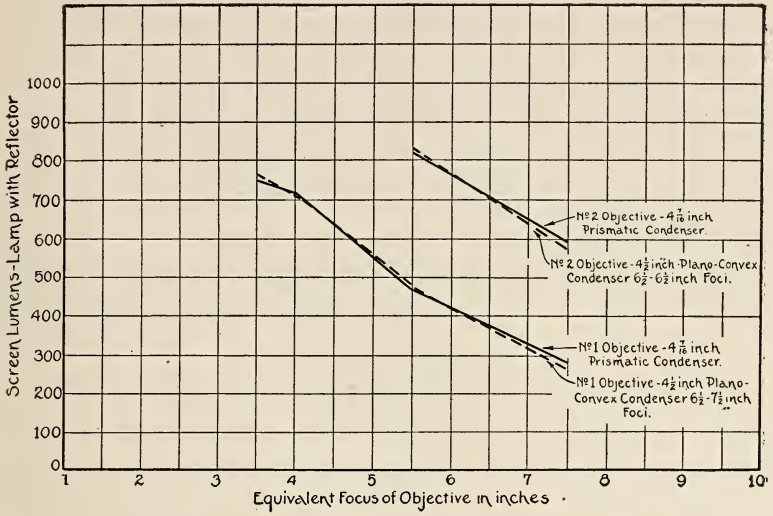


Fig. 2—Light Flux Projected to Screen with Prismatic and Plano-Convex Condensers of 4½-inch Diameter

a choice both as to condenser focal length and working distance. In such cases, operating distances common to more than one objective were selected, making it possible to reduce the recommended number of working distances and condenser combinations to the four given below. For the No. 2 objectives a condenser and working distance combination is included which is not suitable for slides, but which gives considerably more light for motion picture projection.

While these working distances are not the same as those which have been standard practice, they give greater screen lumens; the difference is small, however.

Objective Lens Size	Equivalent Focus Inches	Plano-Convex Condenser Combination	Spacings	
			Condenser-Aperture	Source-Condenser
No. 1	3½ to 5½	6½-7½	8	4
No. 1	5½ to 7½	6½-7½	9	3¾
No. 2	5½ to 7½	6½-7½	9	3¾
No. 2 (Motion pictures only)	5½ to 7½	6½-6½	8	3½

The graphs of Fig. 2 show that there is no appreciable difference in the light obtainable on the screen with prismatic and plano-convex condenser lenses of 4½ inches diameter, with correctly set reflectors. As is discussed later, the inability in practice to obtain the exact reflector setting with plano-convex lenses limits the comparison to laboratory equipments.

They emphasize the enormous waste in light accompanying the use of No. 1 objectives in focal lengths above 5½ inches. Tests with the better grade of No. 2 objectives commercially available today show excellent definition and freedom from aberration, fully equal to the results obtained with the No. 1 lenses ordinarily employed in the past. Since double the amount of light will be projected to the screen when No. 2 lenses are employed, only objectives of this size and of the best quality should be used in every installation requiring focal lengths above 5½ inches.

The data of Table 4 and the curves of Fig. 3 show the wide variation in condenser-aperture distance permissible with the prismatic

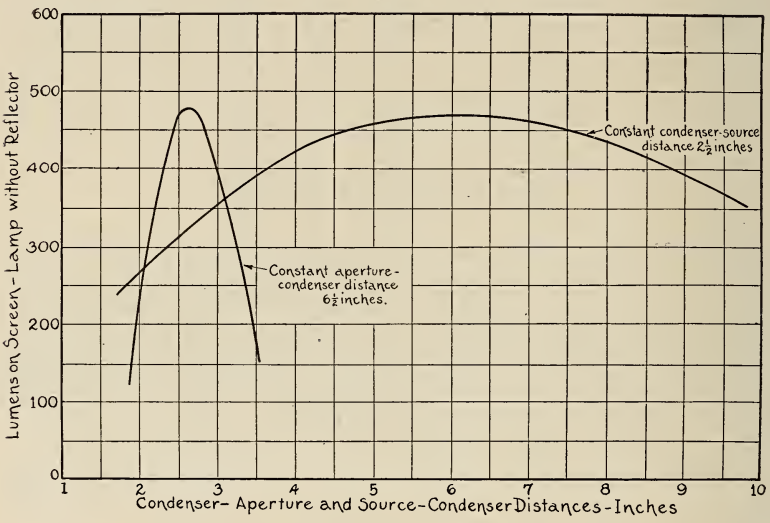


Fig. 3—Effect of Changing Working Distances for 4½-inch Diameter Prismatic Condenser and 5½-inch E. F. Projection Objective

condenser when the specified source-condenser distance of 2½ inches is used; a range of from five to seven inches is possible with no marked change in evenness of illumination or total flux projected. No other source-condenser and condenser-aperture working distance combination gave appreciably more light than the specified distances (2½ and 6½ inches).

For the plano-convex condensers the limits as they affect the evenness of the screen illumination are narrower, and particular care is necessary to insure that the specified working distances are used.

In the laboratory careful adjustment of the mirrored reflector is necessary for the plano-convex condensers, if maximum screen illumination and uniformity are to be obtained. In practice this is very

TABLE 5—SUMMARY OF SCREEN LUMENS AND EVENNESS OF ILLUMINATION DATA FOR PLANO-CONVEX AND PRISMATIC CONDENSERS OF 4½-INCH DIAMETER

Condenser Lens	Source Condenser Spacing	Aperture Condenser Spacing	Lumens on Screen		% Deviation from Avg. Foot Candles (With Mirror)		% of Avg. Ft. Candles		Appearance of Screen†
			Bare Lamp	With Mirror	Max.	Min.	Avg. of Values Above Avg.	Avg. of Values Below Avg.	
No. 2. 5½″ E. F. OBJECTIVE									
6½-7½ Pl. Cvx.	3¾x	9x	433	760			118.8	86.1	E*(A)
6½-7½ "	3⅝	11	432	751			119.5	83.9	E*(A)
6½-7½ "	3½	11	399	712			116.1	85.6	E*(A)
6½-6½ "	3½xx	8xx	474	835			116.5	82.7	G*(A)
6½-6½ "	3½	9	459	797			123.5	78.7	G*(A)
Prismatic	2½	6½	481	828			104.5	94.3	A(AA)
No. 2. 7½″ E. F. OBJECTIVE									
6½-7½ Pl. Cvx.	3½	10	311	545			104.4	93.9	G*(A)
6½-7½ "	3½	11	322	582			107.5	88.6	G*(A)
6½-7½ "	3¾x	9x	316	555			—	—	G*(A)
6½-6½ "	3½xx	8xx	329	581			107.4	90.6	F*(A)
6½-6½ "	3¼	9	326	580			107.6	89.7	E*(A)
6½-6½ "	3¼	10	328	573			112.0	85.9	F*(A)
7½-7½ "	4¼	9	254	466			106.3	92.9	F*(A)
7½-7½ "	4¼	10	297	535			104.3	92.4	G*(A)
7½-7½ "	4	11	286	505			104.3	93.5	G*(A)
Prismatic	2½	6½	339	598			105.3	93.5	E*(AA)
No. 1. 3½″ E. F. OBJECTIVE									
6½-7½ Pl. Cvx.	4x	8x	431	766					G*(A)
6½-7½ "	3¾	9	392	710					F*(A)
6½-7½ "	3¾	10	402	718					G*(A)
Prismatic	2½	6½	431	750					A(AA)
No. 1. 4″ E. F. OBJECTIVE									
6½-7½ Pl. Cvx.	4x	8x	404	711					G*(A)
6½-7½ "	3¾	9	384	670					F*(A)
Prismatic	2½	6½	403	714					A(AA)
No. 1. 5½″ E. F. OBJECTIVE									
6½-7½ Pl. Cvx.	4	8	264	466	10.8	9.0			G*(AA)
6½-7½ "	3¾x	9x	268	480	7.5	6.6			G*(AA)
6½-7½ "	3¾	10	266	486	7.7	16.5			G*(AA)
6½-6½ "	3½	7	259	464	8.2	7.5			G*(A)
6½-6½ "	3½	8	262	479	8.4	13.1			G*(A)
6½-6½ "	3¼	9	258	469	8.5	13.0			G*(AA)
7½-7½ "	4½	9	252	461	7.9	9.2			G*(AA)
7½-7½ "	4½	10	266	479	8.9	20.3			E*(A)
7½-7½ "	4¼	11	251	462	11.6	25.3			G*(A)
Prismatic	2½	6½	255	471	11.8	11.8			E*(AA)
No. 1. 7½″ E. F. OBJECTIVE									
6½-7½ Pl. Cvx.	3¾x	9x	154	278	5.4	5.2			F*(AA)
6½-7½ "	3½	10	157	280	7.7	6.4			F*(A)
6½-6½ "	3¼	8	154	276	6.0	5.0			G*(A)
6½-6½ "	3	9	154	274	8.4	5.7			F*(AA)
7½-7½ "	4¼	9	149	266	6.2	4.9			G*(AA)
7½-7½ "	4¼	10	154	278	6.3	5.5			G*(A)
Prismatic	2½	6½	161	287	12.8	16.2			E*(AA)

x Recommended Spacings xx For motion pictures only

† Parenthesis denotes appearance with mirrored reflector.
Asterisk denotes screen not suitable for motion pictures.

difficult to obtain; observation of the screen during a performance, and of filament images on a card with the lamp operating at from 30 to 50 per cent normal current is not practicable in theaters from both operating and equipment standpoints. The most practical method of obtaining *good* reflector adjustments with these condensers in theaters is by the observation of four images of the filament on a card held about five inches in front of the dowser, as projected through four pinholes in the dowser, placed on both sides of, and above and below, the optical axis. The pinholes should be placed about 1½ inches from the optical axis. Experience with plano-convex condensers and MAZDA lamps in service has demonstrated that these semi-laboratory methods of adjustment give inferior results in the hands of even experienced projectionists, and other simpler methods of adjustment are actually used which result in a sacrifice of screen illumination or uniformity, or both.

On the other hand, with the prismatic condenser the mirrored reflector can be easily and satisfactorily adjusted by the observation of the filament images on the fire shutter coming from a single pinhole in the center of the dowser. The projection of a maximum amount of light is assured, with a high evenness of screen illumination.

The effect of placing a slide holder permanently in front of plano-convex condensers on a motion picture projector, is shown by the following typical data for 6½ and 7½-inch lenses and a 5½-inch e. f. No. 2 objective.

	Distance Slide Holder to Lens	Slide Holder Aperture	Lumens on Screen—Per Cent
Slide Holder in Position	$\frac{1}{32}$ Inch	$2\frac{3}{4}'' \times 3\ \frac{9}{16}''$	70.5
Slide Holder Removed	——	——	100
Slide Holder in Position	1 Inch	$2\frac{3}{4}'' \times 3\frac{9}{16}''$	83
Slide Holder Removed	——	——	100

The slide holder is ordinarily placed within one inch of the condenser in order that the slide will be evenly illuminated over its entire surface. The resulting loss in light of from 15 to 30 per cent should be avoided by provision for either sliding the holder to one side, or raising it above the path of the beam during the projection of motion pictures. This has not been the practice, with resulting loss in screen brightness.

GENERAL CONCLUSIONS

With accurately adjusted mirrored reflectors, there is no appreciable difference in the amount of light obtainable on the screen with commercial types of plano-convex and prismatic condensers and 30-ampere, 28-32 volt MAZDA C lamps for motion picture projection.

Prismatic condensers give better results in service, due to ease of setting the mirrored reflector as compared with the difficulty of obtaining in practice the exact adjustments necessary for plano-convex condensers, and to the smaller sacrifice in evenness of screen illumination when the exact working distances are accidentally changed.

If a slide holder is placed in front of plano-convex condensers on motion-picture projector lamp housings, provision should be made for moving it out of the light beam when motion pictures are being projected. Failure to do this introduces a light loss of from 15 to 30 per cent.

High-grade No. 2 objectives regularly available project twice as much light as do No. 1 objectives with no sacrifice in the quality of the projected picture.

Discussion on Mr. Egeler's Paper

Mr. Victor: Mr. Egeler, why is it that in your comparison you were not using the triple condensing system? Why didn't you use the meniscus and two plano-convex?

Mr. Egeler: The tests which were covered in this paper were conducted to obtain certain information regarding condenser lens systems now on the market used in the projection of motion pictures in theaters, and the lenses most widely used are the 4½-inch diameter prismatic and plano-convex in the 6½-inch and 7½-inch focal lengths; there appears to be no apparent standardization of the triple condenser lens systems in use. In other words, we were not investigating the possibilities of condenser design, but were making a comparison of the two most widely used types.

Mr. Victor: There has not been any attempt, in other words, during your test, to get maximum results out of the two types of condensing lens systems?

Mr. Egeler: Our purpose was to determine the merits of the plano-convex and prismatic types, but not to go into other combinations, such as triple combinations, or whatever number may be used to get better results.

Mr. Victor: As I take it, the whole thing sums up about this way: you have taken into consideration a type of condensing lens which is somewhat new, so far as practical application is concerned, to motion pictures, that is, the prismatic type, and the old style condensing lens system, which also lent itself to the projection of lantern slides, but the most efficient system, the triple condensing lens system, which can be used both for motion pictures and slide projection you have not dealt with.

Mr. Egeler: I agree with the suggestion you make there, that there are other systems which will probably give better results, but, as I say, for the purpose of the test we did not try to investigate all possibilities, but rather to deal with those two used most commonly in the past, with incandescent lamp theater equipments.

Mr. Victor: That is what I wanted to bring out.

Mr. Kroesen: One point that I want to ask Mr. Egeler about is if he accomplished all his focusing of the lamp forward and back by means of the small pin-hole in the douser. My reason for asking that is this: that we have a very elaborate method by which the lens, but in most cases in front. I might say the purpose of this test holes are actually perforated in the douser, but in the course of manufacture we find that it is absolutely impossible to get the perforation on the optical axis at all times, which will necessarily make a difference in the maximum amount of light obtained on the screen when using these perforations, and what I had in mind also was if there could not be a certain amount of error in Mr. Egeler's maximum amount of light obtained where the corrugated lenses were used, if he did his focusing on that basis.

The second point I want to ask Mr. Egeler is, could that same

result be obtained in practice—that is, in a booth where the mechanism is at the present time, and what he would say is a permissible screen—that is, permissible even screen, evenly illuminated.

Mr. Egeler: With regard to the first point Mr. Kroeser has brought up, before the tests were run, determinations were made of duplications of settings of lamps and mirror reflectors by several focusing methods, and it was found that the most exact method which could be used was that which I mentioned, namely, the observation of images on a card placed in the optical system. For best definition of the image, this card may be in back of the objective was to find out the possibilities, and later see the results that might be obtained, so far as possible, in practice. We got the best images by this focusing on cards, so that method was selected as being the most exact.

The second question brought up was as to the possibility of obtaining these results in practice. The means which has been used in practice for focusing the mirrored reflector with the incandescent lamp has been the observation of the image on the fire shutter, produced by a pinhole placed in the douser.

We find that some variation is encountered by this method, and the degree of variation encountered depends on the condenser system. In fact, by this method, we find it impossible to duplicate the setting, with the plano-convex condensers. You might duplicate one in a dozen, but you could not duplicate them with regularity by the pinhole method, unless it was modified to, say, 4 pinholes, and the images observed on a card placed not at the fire-shutter, but some distance from it, and even that method leaves something to be desired. That is why the methods of reflector adjustment for the two condensers was discussed at considerable length in the paper, and the fact was emphasized that with the prismatic lens we found that the single pinhole image observation method can be duplicated, and that is an entirely practicable one in service and a very simple one to use.

Mr. Kroesen: My last question was, what would you deem to be a permissible screen.

Mr. Egeler: In the tests as they evolved, it was shown that for the plano-convex condensers the amount of light obtainable on the screen depended on what unevenness of the screen illumination is permissible. As we increased the distance between the condenser and the light source the screen became uneven, but on the other hand more light passed through the aperture, since the image became smaller. Therefore, we had to determine what was permissible unevenness. That was done by having a number of observers give their opinion as to whether the screen as used had that unevenness which would be noticeable in a theater during the projection of a light density film, or the projection of animated cartoons, in which unevenness of screen would be most noticeable, and we took those settings which gave just that amount of light where we thought the layman would begin to notice it.

Mr. Richardson: There is one element in the matter of screen

illumination which Mr. Egeler has apparently entirely overlooked. It is by no manner of means mere unevenness of illumination which marks the limit of amperage, because unevenness of illumination caused by loss of light through inability of the projection lens to pick up the entire beam, has the effect of reducing perspective and giving the effect of a flat picture. In other words, under that condition depth and perspective is very largely decreased.

Another thing I do not quite understand is where Mr. Egeler has obtained his data concerning the efficiency of the three combination lenses. How can a three combination lens have greater efficiency than a two combination of equal free diameter, when we already have our light source very close to the collector lens, and the addition of the third lens sets up additional light loss of eight or nine per cent, provided it be kept perfectly clean—very much more than that if it is not.

Another thing, you said certain things happened with a high grade projection lens, with the best possible. My experience is that there isn't anything on the market but the best possible. However, I don't quite understand what you mean by "the best possible." You apparently referred to some particular thing. Did you or did you not? Pardon the way I put that last question; I don't mean to draw out the name of any particular lens; I mean did you refer to any particular thing?

Mr. Egeler: Talking first about other possibilities, it is possible to put the light source closer to the condenser than is done with either the types of lens I have mentioned.

Mr. Richardson: Is not the globe almost against the lens now with most condensers?

Mr. Egeler: No; there is at least a half-inch with the prismatic and a considerably greater distance with the other lens.

There are a number of different makes of projection objectives obtainable on the market. We obtained those which gave the best definition, and used those as a criterion as to what results could be obtained.

Mr. Victor: Mr. Egeler has practically answered the question Mr. Richardson asked me.

Mr. Richardson: Yes, I seem to have been mistaken.

Mr. Victor: But the reason we use the triple system at all is to obtain a shorter focus. Now, you can get the same shortness of focus with two condensing lenses, but the glass becomes too thick for practical purposes, so we divided into three. Furthermore, the meniscus lens will intercept a wider angle of rays than the plano-convex.

Now as to the nearness of the light source to the back wall of the back condenser, in my particular type of machine, it is ½ inch away from the glass, and yet it covers the standard film aperture.

Mr. Kroesen: I want to have Mr. Egeler bring forth, so that it can be understood, that reference to the short focal length of the plano-convex which he has designated, and the fact that it will still require two condensing lens systems, one for stereopticon and one

for motion pictures. Am I right in that, if motion pictures and slides, stereopticon slides, were operated from the same light source?

Mr. Egeler: Determinations were first made as to the working distance which would give the maximum amount of light for motion picture projection, as being the criterion, and it was then determined what these settings were. As to slide projection, if you refer to the plano-convex settings as given on page 7, of advance copy, you will not that in the case of the No. 2 lens, we found one setting the 8 and 3½-inch for 6½and 7½-inch condensers which gave greater light for motion picture projection, but if the plano-convex system is to be used for both, motion picture and slide projection, then the 9 and 3¾-inch working distance for 6½ and 7½-inch condensers is best. In the other cases, the maximum amount of light would be projected for motion pictures and still slides could be projected with the same working distances.

The only thing that stops us, gentlemen, from getting maximum efficiency out of condensing lens systems is the use of the lamp. Now that is your first important point in this whole reasoning. I am going to show you very simply why that is so. You project a lantern slide and you use for the purpose of concentrating the light on the slide and to the objective, a condensing lens. Different forms have been used, from the very simple bi-convex to two plano-convex, the triple lens system, and so forth.

Now, then, what would you think of a man today who designed, say, a 4-inch lantern slide and a 10-inch condensing lens for it, and set the slide about 10 inches away from the condensing lens? Why, it is absurd, but that is exactly what we are doing in motion picture projection today.

Now, if in lantern slide projection we use a condensing lens which is just large enough to cover the slide, why do we not use in motion picture projection a condensing lens just large enough to cover the picture element?

That gives us a small, inexpensive condensing lens, very thin, very accurate, but we cannot put our light source as close to the back wall of the back lens as we should.

Mr. Richardson: Why can't you with that kind of a lens?

Mr. Victor: You can and obtain pictures about 15 foot diameter with a candle-foot and a half, but that is your limit, but you can do that now, and it is being done, and none of you gentlemen have mentioned that is possible.

You do that by means of three lenses; the back one is a meniscus, and 2 plano-convex, and a very small incandescent lamp. We have a T-10 in our work; others use a T-8.

So far as I know, in motion pictures, this system was first employed commercially by the Pathés.

Dr. Story: May I say just one word? In regard to this 3-lens condenser, it seems to me that the principal reason why the 3-lens condenser offers any particular advantage over the 2-lens condenser is because in using a very small source, when you put that source to your condenser, you get a widely divergent beam on the other (illustrating by means of blackboard) side of the condenser.

Now, your distance from the aperature plate to the projecting lens is so large as compared to the dimensions of the condenser that your objective does not take as much light as it would if your condenser were further back. In addition to that, we have, of course, the immaterial, possibly, 10% loss in the additional lens, which is entirely a dead loss with the 3-condenser system.

Now, I should be delighted to make a test of any lens which you will furnish us. I have made that offer—it is absolutely open to anybody, whether they believe the results of it or not. We should like very much indeed to try it out. (Laughter.)

Mr. Victor: Dr. Story, I am very glad you brought that up, because before I stood up because I couldn't stand it any longer, I looked around to see if anybody would help me, and I had taken that into consideration, but we are dealing with very small diameter condensing lens, and therefore your light beam at its widest is not as large as when you use your large diameter lens.

Mr. Richardson: You have 4% less service.

Mr. Victor: You have a very wide light beam here (indicating). It crosses somewhere here (indicating). Here is your film aperture (indicating). It crosses here, bringing this to a focus on the film element. Now then, on the other side we get, of course, a light beam which is very wide, but when you narrow this down to a very small condenser lens—we will put it up here—which is no larger than the film, or no larger than to comfortably cover the film element, this is really what happens: you get that (indicating) effect, and at no time is your light beam of a great diameter, so we find that we can use the smallest objective that is ordinarily used and amply take in the entire cone, even with a 5-inch focus objective.

Mr. Victor: If we take the next largest objective, we can take care of a 6- and 7-inch focus.

Mr. Story: May I have the benefit of the blackboard for just a minute? I think Mr. Victor, that perhaps we disagree in your assumption of this point source of light. If we consider simply the light from a point source, it is perfectly true that with such a system of lenses, making them small, putting this point light close to them, you can get exactly as much light through your condenser as with any large system.

Now, unfortunately, we have no point source of light. If we had, we would illuminate the world.

If you consider this as your source ((illustrating by means of blackboard); if you put in here a condenser of any sort—I am going to represent that as a line simply—whether you call it two or three, or any number of lenses, in that condenser. If now, over here, you have your aperture plate and beyond here you have your objective, represented in this way—I don't care what kind that is—now, your light; obviously the light from the center of this comes up to the top of the condenser and so through the center of this. If that be focused at this point, it goes through the center here, but the light from the beam, a beam of this sort, going through there makes a corresponding angle on this side, and so comes out at some such line as that, being stopped there.

If, now, to bring this whole business up to a small condenser here, with your light source there—suppose that is the same angle—then, when this comes up here, that misses out on your objective down here.

Mr. Victor: It is a matter of getting close enough with your light source to the condenser so as not to have the rays cross before they reach the picture element.

Dr. Story: All right; suppose you focus out here. You mean focus at this point?

Mr. Victor: At the equivalent focal point.

Dr. Story: That means that either you use a large source here, or else you bring this very close to that, does it not?

Mr. Egeler: I wish to call attention to one point which does not always happen in service, and that is the fact that the focal or image point of the condenser is not always, and with Mazda lamps is never, at the aperture, and therefore in service we have complications due to spherical distortion at various points in the beam. Putting the image purposely far away from the aperture with the result that we have there does not always apply in practice, because—

Dr. Story (interposing): There is no such thing with any of these lenses as strict images. You get an image with a part of the ring of the condenser, extending on out further and further as you get nearer to the center of the condenser, but if you mean by the image of the condenser the point of maximum concentration, then it doesn't give you a uniform illumination if you use the plano-convex condenser, but it does give you practically uniformity if you use the prismatic condenser properly set.

Mr. Egeler: With the prismatic there are several conjugate focal points for the different rings.

Dr. Story: The different rings are put in their right place; the images are put in the right place to fall upon the gaps.

Mr. Victor: Is it possible with a large light source to get a parallel beam of light in the margins of the rays from the condensing lens?

Dr. Story: What do you mean by "parallel beam of light"?

Mr. Victor: We assume that we have a single lens. We will use a bi-convex, and have a 1-point light source. It will be possible to get our rays about parallel after they merge?

Dr. Story: Yes.

Mr. Victor: Can that be done with a large surface?

Dr. Story: No.

A Member: How about spherical correction?

Dr. Story: A small amount of spherical aberration does no real harm. Let me draw another diagram. Here is your aperture out here (illustrating). The light from this point comes up there. Suppose it is focused out here on this plate. In a projecting lens, then, the light from this point is lost, over here, because it is stopped by the diaphragm.

Now, a certain amount of spherical aberration will simply bend —oh, I had better draw the other one, too—the other one comes

down here, and goes through the aperture. A small amount of spherical aberration, then, will simply bend this light beam down. Now, eventually this piece will be lost out here, but there will be light supplied by increasing the angle here. A certain amount of spherical aberration will do no real harm.

Mr. Richardson: Isn't it a fact that the magnification of the light source will be equal to distance from the center of the condenser to the aperture—divided by the center of the condenser to the light source?

Dr. Story: It will be in that proportion.

Mr. Richardson: You cannot get that amount of magnification, it seems to me.

Dr. Story: You can get this quantity of it—this quantity of magnification.

Mr. Richardson: You are showing magnification to cover the whole aperture and considerably more. I don't see how you can do that with Mazda projection.

Dr. Story: This is 6½ inches, the way it is ordinarily run with that condenser. This (indicating) is 2½ inches.

Dr. Richardson: That would be three.

Dr. Story: In other words, it is carried up almost three times. That is, the diameter of this, or any similar line would be one and a half, across any particular line, which is more than enough, even assuming spherical aberration. Of course, Dr. Gage can tell you more about that than I can, but, as a matter of fact, it takes up most of the spherical aberration.

Mr. Cook: In all your diagrams you have shown a distance from the condenser lens to the aperture, which is very much greater than the lens combination Mr. Victor is describing. I think we are discussing two entirely different problems. You say you have a distance from condenser to aperture that is very nearly the diameter of the lens.

In the system Mr. Victor speaks of, and which is also used by our concern, and has been for many years, the condenser element is close to the aperture, and the light is almost a parallel beam. As a matter of fact, the spot is almost the identical size of the aperture and every bit of light goes through there.

Mr. Richardson: That is where you are very close to it?

Mr. Cook: Yes, but Dr. Story is describing the existing system, instead of what Mr. Victor brought out for discussion, a different type.

In the miniature the condenser projector is 36 millimeters in diameter and the aperture is about two-thirds of it, so that there is practically no light lost.

The image of the filament is sharp from a distance of a little beyond the equivalent focus of the objective lens, clear on to infinity.

Mr. Richardson: And you have very little spherical aberration?

Mr. Cook: Very little. All you have to do is take your objective lens out and move the light source back and forth until you get a perfectly sharp screen image of your light filament. You use

a small source here with about a 72° angle, and the condenser is within a half-inch of the film, so there is no loss of light there.

Aren't we sticking to the old system simply on account of the lantern slide necessity, rather than adopting a thearetically correct system if it is applied only to motion picture projection?

Mr. Egeler: Mr. Cook brought out a point there about the very excellent utilization one gets if his condenser is nearly the same size as the aperture, but there is a limitation. The reason that design has been along the line of large condensers is from the necessary consideration of heat and radiated energy, and limitations in the light output of the source itself; in projection with condensers near the size of the aperture, you cannot make a lamp that will give you the large amount of light you want.

Mr. Cook: Not yet, but we are approaching it.

Mr. Egeler: Some day that may be done, but not yet.

Mr. Richardson: Here is a thing. Some of you already know about it, some do not. Something like four years ago I was called upon to go up somewhere in New York to look at what was known as a "Boy light concentrator." I was told two years ago that that was impractical. It is not; I saw it done about three weeks ago. I saw one of the most beautifully illuminated pictures I have ever looked at, and there wasn't a sign of a "ghost" on the screen, and it is the coming thing in Mazda, I believe.

The thing was made just like this (illustrating on blackboard). The light source was here, and the aperture here, 16 18 inches, and your direct rays came here. Your light comes forward like this—through all these different zones, and here this way.

Dr. Story: I want to take that as a beautiful example of just the thing I mean. Here he has a reflecting surface. If you could get a small spot of light there, a mathematical point, you could get every speck of light from this whole outfit through that screen.

Mr. Richardson: We did it without the point source. It was a small automobile lamp, and it made a 15-foot picture bright with no "ghosts."

Dr. Story: We have a light source—it is not mathematical—let us draw it in there, something like this. Now, the light from the center of that small source comes over to this point and from there is reflected back through the center of this point. The light from the bottom of that source comes up say to the same point on the mirror, and is there reflected back in the same general direction, but making the same angle here that those two lines make there. Accordingly, when this light comes back here, whether or not it comes inside that opening is going to depend on this distance and that angle.

Mr. Richardson: Doctor, we got, I should say, nine-tenths of the light within a half-inch circle.

Dr. Story: If you can get 90% of the light through the source it is fine.

Mr. Victor: Take an ordinary reflector, such as we use in combination with our triple condensing lens system. You remove the condensing lens, and you move your reflector forward, and you

get a most marvelous illumination on the screen, but it is absolutely useless for projection on account of the large light source.

I gave up all my hopes of getting that wonderful illumination due to that fact.

As Dr. Story said, if we had a one-point light source, a special reflector could be made doing away with all condensing lenses, and it would take very little illumination at the source to give us a wonderful screen picture.

Mr. Richardson: Why do you say it is useless, even under that condition? Why it is useless, if you get the light to the screen? I don't quite get your point.

Mr. Victor: Well, I could explain it to you in time, but I think someone else could do it much quicker. I will cite as an example of the efficiency of the small diameter triple condensing lens system, the following: I have recently perfected a printing machine, an optical printing machine, for printing pictures from standard negatives to safety negative prints.

I first experimented with a 1,000-watt lamp in a large housing, and found I had difficulty, even then, with so much illumination, in printing dense negatives. Subsequently I substituted a 1,000-watt lamp for a 2 ampere 24-candle power, 9 volt, Ford automobile light, in conjunction with this precondensing lens system, and found I was burning up my prints, no matter how dense they were, so I had to reduce the illumination by means of a rheostat, and close my aperture down to 8½ in the lens I was printing with.

Now, that should be conclusive, and all this time you can take the lamp out, which contains this globe, which is not over 2½ inches in diameter, and hold it in your hand while you print, and you can also leave that negative indefinitely in the aperture with the full light on.

Mr. Richardson: Yes, but you haven't enough light for your projection.

Mr. Victor: I was stating a comparative condition between a 1,000-watt lamp and a light of a small candle-power used with the condensing system I have just mentioned.

Mr. Johnson: Mr. Victor, wasn't that a parabolic reflector you have reference to in all your experiments?

Mr. Victor: No.

Mr. Johnson: What did you use?

Mr. Victor: I used a type of reflector which I understand is not parabolic.

Mr. Johnson: What is it near, an elipsoid?

Mr. Victor: No; it would be a portion of a sphere.

Mr. Johnson: What Mr. Richardson is speaking about is a sort of an ellipsoid reflector, which is only possible to generate by the construction of special lapping tools, and as to the test he has reference to, I saw a 30-watt automobile light give to the eye as much illumination as the present 900-watt motion picture light, so that what he says has quite a bit of merit as a projection matter, but it is difficult to obtain, due to the generation of this special reflector,

which was nearer an ellipsoid than the parabolic arrangement used by most people, and by being able to pull this light back through the hole in the back of the reflector, it was possible to get as near to one point source as it is commercially possible. I personally saw the demonstration and am convinced there is a great deal of merit to this if you have the proper tools and they are able to generate this ellipsoid thoroughly.

Mr. Porter: I would like to ask Mr. Johnson if at that demonstration he actually saw a film projected with that outfit, or if he simply saw the screen illumination. I would also like to ask him if he knows at what temperature the lamp was run.

Mr. Johnson: Answering the first question, I did see a piece of film projected, and as to the second, the lamp was run at what the manufacturers recommended it to be run at. There was no occasion to strain it, or do any running other than what the lamp called for.

I think the results derived from simply making it possible to cast and design this special tool, so that we could generate it, and lap it over, and not have any break-up in the occular system, is a perfectly wonderful piece of mechanical work, and that is why you get those results.

Address of Mr. F. W. Stratton,

DIRECTOR OF THE BUREAU OF STANDARDS

I don't know just where your field begins, or where it ends, but I do know there are a good many questions, a great many problems that arise in connection with your work, and with the whole moving picture work, that touch very closely upon the work of the Bureau of Standards.

We are frequently called upon to examine new devices that come up, devices for stereoscopic projection, and devices for projecting in color, and there are a number of very important outstanding problems in this whole matter with which the Bureau may at times be ready to help.

Nearly all these improvements are based upon the application of some scientific principle. Great improvements are sure to be made in the films in the future. The fineness of grain, and matters of that sort. From a scientific standpoint we are very anxious to produce films of a much finer grain, if it is possible. Of course, the finer the grain, the slower the film. Now, we want fineness of grain and speed at the same time. If we can discover some of the fundamental principles involved there it may enable the manufacturers to produce better films.

There are a number of different fields in which the Bureau can be of great assistance. The Bureau's work is divided up generally into the fields of physics—we have a division which has to do with weights and measures, and by weights and measures we mean the ordinary measurements of length and weight and capacity, specific gravity, density, and so on, that you come in contact with indirectly.

The manufacturers of moving picture apparatus will in time build their apparatus by the use of standard gauges, and so on. That is, it is an ordinary problem of manufacture.

We have an Electrical Division, which has to do with matters pertaining to electricity, not only the standardization of electrical measurements and methods of making electrical measurements, but the electrical performance of various devices, and in many cases you will come in contact with electrical performance of your apparatus. This Division is very much interested in the formation of electrical safety codes, and that is a thing that comes very close to you, the safety code.

And, there is a Division of Heat and Temperature. This Division has to do with all questions pertaining to the measurement of heat and the heating qualities of material, their insulating properties, their conducting properties, and melting point, and things of that sort. In fact, that Division has carried on a number of investigations for the Government, and I think for some manufacturers in regard to the inflammability of films, and the fire risk involved in films.

There is an optical division which has to do with matters pertaining to optics. It is the province of that division to take up questions pertaining to optical systems, no matter what that system is for, and the Bureau has a glass plant. It can make the optical glass required for those systems. If we want a special kind of glass, we

make it. If we want a special form of lens, we make it, and that is absolutely essential if we are going to improve these systems, and lead the way in optical matters generally.

I can give you a great many cases where people are interested in the development of moving picture apparatus, who have come to the Bureau for systems along optical lines.

Then, we have a Chemistry Division, which is interested in the various kinds of materials involved. Any problem that you may take up, whether it is in the development of a device or the engineering concerned, or the operation, whatever it is, is bound to come in contact with scientific data. That is true of nearly all professions or fields of endeavor today, and it will be a very convenient thing if you know where you can go with questions of that kind and have them answered in many cases—not in all cases. Frequently the putting together of the experience you have and the scientific knowledge our experts have, will bring out something better than you had before.

We have other divisions which have to do with material. It is our business to know about the leading materials, the alloys and various building materials. The question of materials frequently enters into such devices.

Then again, I think we are sure to enter a more useful period of the motion picture work. At the present we are concerned chiefly with its amusement properties. There are many efforts to do educational work with the motion picture film, and I have had many talks with the principal men in the moving picture business. They often, especially those that are interested in the production side of it, seem to discredit or ridicule the educational side of it. They say the people do not want it.

Now, the people are becoming educated to the other thing, and as time goes on we are going to see an enormous application of moving pictures to education—analysis of motion, movement, the teaching of all sorts of things.

If I should go back to the class room and teach physics again, I should certainly use the moving picture to illustrate many of the phenomena, many of the mechanical movements.

There is no end to its application.

Now, that is all going to call for remodeling of apparatus to suit particular needs. In a very short time the small portable apparatus will be very popular. The time is not very far away when it will be almost as popular as the Kodak. It will be more expensive, but small devices are coming into use very rapidly, but they will have to be improved as to stability. There are certain conditions to be met, but you can meet them, and projection in the home is going to come, as sure as can be. It is going to be a very useful form of entertainment, and we must by rapid production reduce cost, and I suppose that is where the engineer comes in.

Now, we are very glad to have you with us this morning, and glad to have you go about the Bureau as you like. Arrangements will be made for you to inspect the Bureau, if you care to do so. I assume you have a regular program of your own, and I am sorry I cannot be with you all the morning, and I wish you to make yourselves at home and get in touch with our experts as far as you please.

Continuous Motion Projector of the Taking of Pictures at High Speed

C. Francis Jenkins

THE prismatic glass-disc-ring described and illustrated in the transactions of the Montreal Meeting of this Society (May, 1920) disclosed, in use, a certain defect which was finally discovered to be inherent in the disc form of prism-ring.

It was found that in such discs there is a dioptric error in the ends of the ring prism due to the cone formed by the grinding. The circular surface of the prism having its base outward involves a minus error, while the prism section having its base toward the axis of rotation involves a plus error.

While it is possible to make this error less by increasing the diameter of the ring, it is impossible to eliminate it within practical limits of machine design.

The plus error has the effect of adding a plus element to the lens combination and therefore to shorten the focus of the objective and increase the width of the picture on the screen beyond the width of the picture projected through the neutral position of the prism ring, i. e., one-half its revolution (to the point where the ring is nothing but a flat piece of glass); the minus error similarly adds a minus element to the lens combination making the screen picture narrower. As these extreme conditions recur with each revolution of the ring, that is, sixteen times per second, the screen picture actually widens and narrows with each revolution of the ring blurring the marginal portions (lateral margins of the screen picture).

After much experimentation it was found that the use of two such rotating discs mounted so as to have their peripheries curving in opposite direction will overcome the error. The arrangement is shown in Fig. 6.

Thus the plus error introduced by one of the discs is neutralized by the negative error of the other disc, and the negative error of one by the plus error of the other disc and the resultant picture on the screen has the sharpness of a screen picture projected in the usual manner.

While this mounting of one disc above the other increases the height of the machine head a little, the advantages of continuous motion, the greater simplicity of mechanism, the 100% increase in light efficiency, the longer life of film used therein, etc., more than compensate.

A different form of prism, named a band ring to distinguish it from the disc ring of the first described form, is shown in Fig. 7. This prismatic ring has its greatest cross-section in a circular plane parallel to the axis of rotation.

Theoretically, a like error exists to that encountered in the disc form, but it is so small that it is negligible. The spherometer which

readily shows the plus and minus error in the disc form fails to show any error in the band form.

As in the disc ring prism the gearing is so proportioned that the ring rotates once while each picture frame passes across the light beam, unless it be a multiple-prism-section ring.

As the angularity of the prism face of the ring changes each revolution from one extreme (base up) to the other extreme (base down) it results that each downward-moving picture frame on the film is projected forward on a fixed line through the projection objective, and the picture remains in fixed position on the screen.

It will be understood that the warped contour of the surface of the ring might occur a plurality of times and the rotational speed of the ring corresponding decreased. The converse is also true, i. e., that the same R.P.M. of the ring will increase the number of pictures per second which can be made through such a multiple-prism ring. See Fig 8. Thus, if a ring having six such prism sections has a 7,000 R.P.M. speed, 700 pictures per second (42,000 per minute) can be obtained. If the ring should have twelve prism sections, and rotational speed increased a little, 100,000 pictures per minute can be obtained. Incidentally, I might add that this number is the goal I have set for myself for the summer.

The analysis of any high speed or quick movement by photo divisions of 700 to 1500 pictures per second is destined to disclose data of great value to the scientist and to the engineer and along many lines, some of which are not yet suggested.

Even one of the simple subjects shown you today made at the slower, 850 pictures per second, speed discloses some heretofore unsuspected behavior of pneumatic bodies. You will notice in the bouncing ball how it squashes on contact with the ground, and how it recovers its spherical shape in very much less time than it takes to rise from the ground a distance equal to its diameter. Apparently the force stored in the ball by its impact is largely exhausted in the recovery of its shape before it begins its rise. I am not aware that this has been observed heretofore, and suggest that this phenomena may account for the heating of pneumatic tires when cars are driven fast over uneven ground, a heating which is much more excessive than is caused by the same speed over smooth roads.

Discussion of Jenkin's Paper

Mr. Jenkins (upon the conclusion of the showing of the film): I certainly am very grateful to you for your patience and your kindness. I don't usually apologize, but I am very much disappointed at the lack of electrical voltage here. I am now going to do the best I can to show you what we have in the way of mechanical difficulties, which have been apparently easily overcome. May I say, please, that we have two forms of camera; one is the prismatic section ring, which up to the present time we have not been able to get more than 350 to 400 pictures per second from, and we have here a camera that is built a little differently, giving continuous motion, wholly continuous motion.

This camera consists of a lens carrier in the shape of a rotating disc, and it carries a plurality of lenses moving past a fixed aperture in the front of the camera-box. We don't know that there is any limit to the number of pictures per second that can be made with that mechanism.

The operator is going to run films through here at a rate which will give us about 820 to 850 pictures per second. You notice that I am talking in seconds rather than in r.p.m., and the reason is we cannot get film enough to last a minute. We have made pictures at the rate of 2,000 a second. I did not bring any samples, because we only had just the one time when we did that. Last week, the week we expected to prepare for this affair here, it rained every day, and we didn't get any pictures at all.

(At this point, a demonstration of the continuous motion picture camera was had.)

Mr. Jenkins: There is nothing strange about the film, either as to size or sensitiveness or anything else. We employed a B. & L. lens, lenses that Bausch & Lomb have been making for me up to this time, standard lenses, put in a special mount.

A Member: What do you run that into when you are taking pictures?

Mr. Jenkins? Into a magazine.

A Member: Can you wind it up that fast?

Mr. Jenkins: Oh, yes, the mechanism is on top, and the receiving mechanism is on the inside. It is the usual arrangement in that form. I shall be very glad to tell you anything that I can, that I have not thought of.

A Member: Is there any static?

Mr. Jenkins: Not a bit. We open the box, wide open. The aperture of the box through which the film moves is about 2½ inches wide—it is a little more than that. We have done away with tension entirely, in the sense that the term is usually used; that is, tension pulls. We do try to give it a little tension by crooking the film, making the film run in a crooked line at the top of the aperture, and that gives us the equivalent of a tension, because as you see, when it shot out here, in the room, a moment ago (at a disappoint-

ingly slow speed), it shot straight out, and as long as you get it to go straight, there is no friction, if you put a kink in it, there is friction. I don't know whether it is the friction of the air, or a change of the material in the film, but we do find that is a very good scheme. We run it down through a narrow channel, but it doesn't touch the film.

Mr. Kramer: Were these pictures we saw here taken with this type of camera?

Mr. Jenkins: Yes, sir; part of them with that very camera.

Mr. Mayer: Does the absence of tension on the film disturb the sharpness at any time?

Mr. Jenkins: No, I don't think so. The channel is about 7/1000 thick, for a 5/1000 film—

Mr. Mayer: That is 2/1000 difference?

Mr. Jenkins: Yes. I think I see what you have in mind, what you are getting at, which is when you have a splice. In the first place, we don't have a splice if we can avoid it. In the second place, there is a spring member.

Mr. Mayer: You have a slight tension at the aperture?

Mr. Jenkins: No, sir; only when a splice goes through. It is just a narrow channel about 2/1000 thicker than the film itself, and that is at the perforations. Now, it is still thicker, and a still larger channel, behind the lens.

Mr. Mayer: That permits of a certain curvature of film, which would disturb its sharpness?

Mr. Jenkins: Not if we get a curve within its length. In other words, this thing (demonstrating), if I bend it this way, keeps a perfectly straight line across here.

Mr. Mayer: Yes.

Mr. Jenkins: And that is what we need. If you curve it a little, it will stay flat, and especially at these high speeds. These high speeds have brought to our attention phenomena of film in high speed movement which we had not suspected. When we think about it, of course, they have been there all the time.

Mr. Mayer: Do you believe that the lack of sharpness in the pictures which you have shown, is essentially due to the crude construction of the mechanism?

Mr. Jenkins: Oh, yes, the lack of sharpness comes from, we are pretty confident, the inability up to now of exactly focusing all these lenses, and at the same time making them exactly the width of the field, and at the same time making them exactly optically centered. It is one interminable job.

Mr. Mayer: In what way is the lack of sharpness, as shown, explained?

Mr. Jenkins: I think that is due to crudity of construction, in this camera and lack of skill in grinding and polishing glass in the other. Those two plates you saw, one you saw at Montreal, and the other here, are absolutely the only two prismatic plates ever made—cracked that it could not be used.

oh, no; I am wrong; there was one other which was so chipped and

Mr. Mayer: They must run absolutely true?

Mr. Jenkins: Unfortunately, for your argument, we find we can throw them out of position 45 degrees.

Mr. Mayer: I didn't refer to that. I referred to the maintaining of the disc perpendicular to the axis, so that there is no oscillation of the disc, like a loose wheel on a flivver.

Mr. Jenkins: I don't think that ever entered my mind.

Mr. Mayer: Don't you think a slight oscillation there would cause a considerable disturbance in sharpness?

Mr. Jenkins: No, that would not affect the sharpness at all, but the lack of high polish on the working surface of the glass disc is what does it, and the way we found out, was to stop it and hold it still and project through the discs without movement. We did that in our laboratory by scratching a piece of mica with a light scratch with a needle, that is projected through there, and it makes a black line on the screen because it disturbs the light. We can leave that stand in the aperture without ignition.

Mr. Mayer: And you get a much sharper image by holding your disc still?

Mr. Jenkins: We do, and we do not. What I mean to say is that the high polish of the ring, all the way round, is not the same quality in all places. We have not yet learned how to do it, but will, doubtless.

Mr. Richardson: In a machine of that kind, what effect is there corresponding to back-lash in shutters? I assume these two discs are together. What effect will the necessary back-lash, due to wear, have?

Mr. Jenkins: I don't think it makes any difference, because it never has had. There is a permissible lack of phase. In other words, we can take these discs and throw them out of phase 45 degrees, and still get a picture that is acceptable.

Mr. Richardson: From what you have already seen of these experiments you have made, do you believe that when the machine goes out into the hands of the men it will have to go out into, it will be difficult to maintain perfect results?

Mr. Jenkins: I don't think so. In fact, I would rather expect it to be otherwise, because the intermittent mechanism today is certainly a wonderful piece of work, and to keep that so that it will project pictures which are steady on the canvas requires care and attention.

Now, I don't think the care and attention necessary to keep the same quality of picture on the canvas would be required in continuous motion picture mechanisms.

Mr. Kramer: Which looks better, the disc machine, or the multiple lens machine?

Mr. Jenkins: The multiple lens machine is only for cameras, but for high speed cameras, I am inclined to think we will never get anything that will give us as high speed as a plurality of lenses. I cannot think of any scheme but one, and that is purely a theory yet. The other will give us better quality, I feel sure of that, although I

think we will get an analysis of at the rate of only 350 to 500 exposures a second, and that will be the limit, but we will get a very high degree in quality.

I have in my hand a lens which the Bausch & Lomb people were kind enough to send down, and when I get this ring skilfully made, I believe that with this lens we can take care of any condition we are likely to be confronted with, and that we will be able to take a picture that will be superior to any picture we will be able to get with a multiple lens. But with a multiple lens camera you can get any rate of speed you wish.

If you just stop a moment and think, you will see that you have no shutter at all in either machine, which means that if we increase the arc of lens travel, until it doesn't depart too far from a straight line, i. e., the straight line in which the film moves, we can keep on exposing that lens as long as we want to. In other words, the picture impinges on the film, and if we can keep it from departing from the spot initially taken on the film, we can move it down and keep on exposing it as long as we like. In other words, we can expose 150% of the time on a lens, if you can conceive of such a paradoxical phrase. In other words, we will have two lenses working on the film at the same time.

I believe that is all right, particularly for extreme high speeds, perhaps speeds that we do not need at all. I am hoping and really believe that a speed of 350 to 500 per second will cover most all of the problems that will be met, but now and then we may want one for the bursting of shells against a plate, or something of that kind, when 2000 p.p.s. will be required.

The Ordnance Department has written me about the advisability of going over to Aberdeen and photographing the flight of a shell. I don't see any trouble about that. As I remember it offhand, the flight of a shell from some of the guns they wish me to test out is about 2,500 feet per second. Now, if a shell is 18 inches long, and we make 2,000 pictures per second, we will have nothing but one black streak, when we project the picture, because there has been no division of exposure. Each shell is overlapped, overlapped on the exposure that immediately preceded it.

I argue that 2,000 per second for a shell traveling at 2,500 feet per second is too many. One doesn't get any analysis at all. It is at too high a speed.

But, it would be useful, for instance, when a balloon bursts. When a balloon bursts, what happens? We don't know. Most of us beat it for the woods, but what else happens? Nobody knows. It may be in such cases as that, that we may need a very high speed, but I believe that they are the exceptional cases.

I am ready to impart to anyone who wants it, such information as I have, or am ready to sit down and discuss it with anyone. We have now learned to take the number of pictures per second that the conditions require. I will sit down with any of you and tell you just how we do it, and, bless you, if you want to tackle the problem alone, go to it. If I can help you, I will be glad to do that, too.

(Applause.)

Color Photography

By Dr. F. E. Ives

Mr. Ives: Gentlemen, the brief demonstration that I am going to give just now is not on the program. A few words of explanation is in order. I really came down here because my very good friend of a great many years, Mr. Jenkins, wrote to me a short time ago intimating that he thought I belonged in the same class as a lot of good fellows who were going to meet here who were interested in moving picture photography.

As a justification for accepting the invitation, I wrote a paper on the color toning of cine film by a new method which I have worked out, and which comes on the program tomorrow. Incidentally it was known that I had been doing some experiments in color cinematography, and it was suggested I might bring along specimens and make a few remarks about it.

The fact is I have been interested in all branches of color photography, having been something of a pioneer in certain lines of work, and, naturally, along with a lot of the others, I thought I would see what could be done in the way of colored moving pictures.

I early came to the conclusion that the only kind of colored moving pictures would be the projection of prints in the ordinary cine film, which could be run interchangeably with black and white, the optical system not being satisfactory from that point of view.

The real pioneer in the projection of colored cine pictures to be run interchangeably with black and white, made on a film of the same gauge and so on, was Hernandez Mejai who patented the idea of coating the film on two sides and making a green print on one side and a red print on the other. He was the real pioneer in the type of color photography which I decided would have to be adopted for cine work, and his method, more or less elaborated, and modified, by others, is to some extent in operation and being exploited today.

I decided that the cost of production was such an important element in this matter that eventually it would be necessary to produce pictures in ordinary positive stock, single-coated, that the difference in cost of single-coated stock would make the difference between commercial success in competition. Therefore, all my experiments were devoted to production of color prints in a single-coating.

The objections to double-coating are, first, the cost of the stock; second, there is twice as much picture surface exposed to damage. Therefore, the films wear out faster, having a picture on both sides. Third, if there is any scratching or injury to the film on the one side, it means streaks or spots of bright red or green, whereas if pictures made on single-coated stock are scratched, the damage has only the same effect as it does in black and white. It simply shows a defect in the picture without showing a bright spot of color.

I have taken out several patents and I commenced making speci-

mens of work about four years ago. Three years ago last winter I went out to Los Angeles and visited the studios of The Famous Players Company, where they were very kind and allowed me to go onto their ground and make exposures on some of their own subjects, and gave me some good ideas.

First of all they agreed that I should get away from the crude reds and greens shown by others who were trying to do work in color cinematography; that even where they were true to nature, they were offensive from an artistic point of view. They said, "We want delicate effects; pastel effects. We want the color to suggest the story. Just as soon as you get bright blotches of reds and greens, so that the people get up and say, 'Isn't that a pretty red or a pretty green', you have ruined the story."

I appreciated this advice, and in all the work I have done I have kept away from crude coloring, and there are no very crude reds or greens in my work. The colors are more or less pastel.

Now, I have done all this work simply as a scientific experimentalist. I have not had proper laboratory facilities. The little work I have done has been done mostly with improvised devices which I made with my own hands, even fixing up my own camera, and I had no previous experience with cinematograph photography. It is only just that some allowance should be made for the fact that I was a rank amateur, simply experimenting from a scientific point of view.

I have with me a few pieces and a short reel illustrating the application of my method. The reel has been abused. It is dirty and scratched, and it was colored for arc light projection. It does make a difference in color projection whether you have arc light or incandescent. This, having been made for arc light projection, will suffer a little from incandescent light. Nevertheless, I think you will be interested in seeing how, even three or four years ago, I was producing in single-coated stock colored cinematograph pictures of great variety and great delicacy of color.

In connection with this development, I devised a camera which makes the two negative images simultaneously. In most of the work done by others the exposures have been successive, in rotation; first green and then red, with the result that if a thing is moving rapidly, it does not keep the same position in the two superposed images, and unpleasant color fringing appears in the projection.

So far as possible the people who worked that system selected subjects in which there was comparatively little motion in order to make the color fringes that would result as little in evidence as possible, but it makes no difference how rapid the motion is with this process, there is no color fringe. I proved that in some photo work on the grounds of The Famous Player-Lasky Company by running the camera at even less than half-speed, in order that the objects should have very different positions in the succeeding images, and naturally they were very jerky on the screen, but there was never a sign of color fringe.

My business associates afterwards gave me orders to take that

part of the roll out, because they said it looked as if I did not know how to run a camera. (Laughter.)

Now, I will give this small piece of reel to the projector, and we will run it through. As I said, it is not in very good order. It would be better projected with arc light, but I think you will see now what will interest you and, remember, that a good part of this roll was made about three years ago.

(At this point Mr. Ives' pictures and reel were thrown upon the screen.)

(Applause.)

Discussion of Dr. Ives' Paper

Mr. Cook: I would like to ask Dr. Ives if standard film without any change in the emulsion was used, or was a particular form of emulsion necessary?

Mr. Ives: The negatives are made on ordinary Eastman film.

Mr. Cook: I mean the positive.

Mr. Ives: Made on ordinary Eastman positive film.

Mr. Cook: Was there any re-sensitation for the second image?

Mr. Ives: It is re-sensitized—as a matter of fact, I will try to explain a little in detail. I made one print and developed it into color. That print is chemically converted into a blueprint. That leaves in the film a considerable amount of unchanged bromide of silver. I say "unchanged,' 'but, as a matter of fact, it is affected to a certain degree by the development. That is not sufficient to make a second print in that is satisfactory. You could make a print, but it is no good for the purpose. The blueprint which is produced by converting the first image is a mixture of Turnbull's blue and ferro-cyanide of silver. The ferro-cyanide of silver I reconvert into bromide of silver. The consequence is when I make the second print, I have the same amount of bromide of silver as I had in the first instance.

Mr. Cook: Then you dry and reprint with the red?

Mr. Ives: Yes.

Mr. Cook: How do you get your red then?

Mr. Ives: Well, I make another image and develop it as a black positive, and then convert it by my dye-toning process. It is bleached and put in a dye bath and takes up the color. There are a number of original features in the process which I have not gone into, which are the subjects of patent. One, for instance, is in the red print. Now, the theory as it has been worked out by others involves making from the red selection negative a blue or a green print; from the green selection negative a red print. Now, the red print which I make is red in the deep shadows; it is orange in the lighter shades, and yellow in the extremely pale shades. Not to go into detail, which is given in certain publications of mine, it works out in this way; that by this means you can get in the landscape blue sky, green foliage, red, orange and yellow fruits and flowers. You cannot do it with a combination of two simple colored images, like the red and green which was previously used.

Mr. Ives: If you have paid particular attention to the attempts made in the processes already exploited, you will see that until recently the colors were crude. There were fruits, like oranges, which should be yellow, and they were simply a degraded red. They were an offense to the eye. I claim by this method it is possible to reproduce the colors of objects which heretofore it was impossible to reproduce in the two-color process. I get about as many colors as in the three-color process, but at a little sacrifice. Cobalt blue photographs like a black; a bright magenta pink would reproduce

as orange, and a very pale lemon yellow would become almost white. Nevertheless, it gives such a close approximation that it is pleasing to the eye and very satisfactory, and very much cheaper than any three-color process possibly could be for this purpose .

Mr. Cook: How is the expense of that compared with double-coating?

Mr. Ives: First of all you save the difference in cost of ordinary film and double-coated film. Just what that difference in cost is I don't remember. I never do remember figures, and don't know much about money. I never have any, anyway. That is the first advantage, and then the handling of single-coated film can be done with ordinary appliances, and the double-coated film because of the two soft gelatine coatings require special appliances for handling.

Mr. Gregory: Mr. Ives, you referred to the publications which you had published, in which you have said something about your work, motion pictures in colors. Are any of these publications available, purchasable?

Mr. Ives: They are rather scattered, and some of the information which might be of interest to you has really only appeared in patent specifications. One of the patents which I regard as of great importance was only issued a few days ago. If you will give me your address, I might find something in connection with the subject that will be of interest to you.

Mr. Richardson: Has the color process anything to do with the lack of sharpness in the pictures you have shown?

Mr. Ives: No; that was due just to plain amateur work done by a man who was interested in color, and had no experience. I had no proper laboratory facilities and never had been in a laboratory where that work was done, so allowance, in justice to me, must be made for the amateur character of the work in some respects.

Mr. Mott: I would like to ask Mr. Ives if this process is the same process used in his still photographs, called the Hess-Ives?

Mr. Ives: No; it is not.

Mr. Mott: Quite different?

Mr. Ives: Entirely different.

Mr. McNabb: I would like to ask Mr. Ives if arrangements have been made for compensating shrinkage; that is, to superimpose the second exposure over the first?

Mr. Ives: I will say in relation to that that when I started these experiments, in printing the second image in on the first, I printed three images at a time. I soon found that wouldn't do, because one film or one negative would shrink more than another and the three images would not all register at the same time. I do it now in a step printer and print a single image at a time. There is sometimes actual difference in the size of the image, but the difference is so small that if the image registers in the center, nobody notices it in the picture.

Mr. McNabb: Wouldn't that account for the lack of sharpness?

Mr. Ives: As a matter of fact, the thing is very completely under control with proper appliances and care.

Mr. Ives: I have a little frame of Eastman positive film here which has been subjected to this treatment with different dye baths. The colors I have used here are perhaps none of them what anybody would use for a particular purpose, but they illustrate the different values, the slight differences of color that can readily be obtained.

I have a black positive here, then a kind of brown above it, and a yellower brown below. In greens I have a yellowish green, and a blue green and dull blues, a sage green, and three or four strips of film here which have been completed, subjected to the bleach, and dyed to colors so transparent that it is nothing but pure color.

I have no doubt myself that because of its extreme cheapness and simplicity this will supersede every other method of putting color into cine pictures. I will be glad to answer any questions.

Mr. Victor: Mr. Chairman and gentlemen, I don't think I can comply with your desire for a discussion. I can only compliment Mr. Ives on his wonderful paper. It is not only, so far as I can tell, a wonderful scientific paper, filled with scientific data, but he has completely advocated what I consider the most common sense method of toning or rather, dyeing films.

The method now employed of toning, as far as I can tell, has one great drawback, and that is a lack of permanency. I have noticed reels—we saw one last night, one of the Williamson submarine pictures—that had evidently been toned with sepia, and we could see what had happened to this print. After having been in use two or three years, or rather having been lying idle that long, it was filled with spots and discolorations, and I don't think, so far as I know, that this system of dye-toning has that fault, and I think Mr. Ives stated that it did not, and his experience has covered so many years in this sort of work that he certainly could inform us as to the outcome of the work.

With respect to the color photography process shown yesterday, it is the simplest of them all. It starts with the ordinary positive film, and is, so far as I know, cheaper all the way through, but I could not give any figures on it.

This method of toning film is cheaper than the others simply because the solution is cheaper. It has other advantages of course, but as I say, the preparing bath for this toning process costs less than a cent a gallon, and it only exhausts with use. It does not precipitate like chemical toning solutions. You can mix up a solution of this and use it six months from now and get the same result you could today. It is very cheap and quite permanent.

That is an interesting fact; this matter of permanency of the prints.

The original toning process was Dr. Traube's iodide process. Now, iodide mordants basic dyes, but does not prevent them from fading in the light. You take an iodide image and put it out in the sun; take malachite green, and it will fade very rapidly indeed. Take this mordant of mine silver ferricyanide, put the same dye on it, and put it out for six months, and it doesn't change color, so that there is some chemical difference in the combination.

Mr. Victor: Mr. Ives has this system been employed in the studios very much?

Mr. Ives: I don't know that it has at all. The fact is, my first publication of this suggestion of only immersing in a dye-bath to prepare without actually bleaching the image—the first suggestion I made of it in a publication only appeared two weeks ago.

Mr. Victor: Is this process similar to that which is employed now in using the subtractive form of color photography?

Mr. Ives: Yes.

Mr. Victor: It is similar, but it is applied to the dye-toning of film?

Mr. Ives: In using it in color photography, you bleach the image completely, using a stronger solution—bleach it down to a pale yellow image, and then dye it. For toning you use a solution so weak, or for such a short time, that it doesn't apparently have any effect on the black silver image at all. Nevertheless, it has prepared it to take the dye. Therefore, we simply add our color to the original black image.

Mr. Victor: Do you allow the film to remain in the dye solution to saturation, or do you have to watch for the depth of tone?

Mr. Ives: You can do as you choose about that. As a matter of fact, there is a limit to the amount of dye it will take up with a given treatment of the bleach, but you don't reach that limit with some dyes in less than a half hour, but you can watch it. You can take it out and wash it at any time.

Mr. Victor: Dr. Ives, as I see this thing, it is a simpler and cheaper way of toning films than the method we have employed in the laboratories?

Mr. Ives: That is what it is.

Mr. Victor: Will you enumerate the advantages of this over the other once more?

Mr. Ives: Well, the preparing solution which makes the film take the dye color costs less than a cent a gallon; the chemical toning solution costs a good deal more. This solution does not precipitate or go bad, with time, or use, except as you actually exhaust it, and you can use the same solution for years if you were to add simply a little concentrated solution to keep up the strength of it, which is not true of any of the dye-toning baths. They all gradually precipitate and go bad.

Again, in chemical toning, you are limited to a certain range of colors which can be obtained with the chemical process, such as peacock blue, with the iron process; reddish brown with uranium; a pink brown with copper. With this, you can have absolutely any tone you choose. You can take, for instance, three or four dyes, which will combine in different proportions to make any color under the sun. You simply choose the color you want and mix your dyes accordingly, and you have got it. It is not a question of what color copper makes, or what color iron makes, or uranium; it is a case of what colors you want, and mixing your dyes, and there you are.

Building a Non-Theatrical Film Library

L. E. Davidson

No. 1—Why the word Library rather than exchange.

A non-theatrical film library is more than an exchange. It performs all the functions with and gives practically all the information about films that a library gives about books. Not only must it furnish films for entertainment but for instruction, reference and special purposes. The films must be organized into courses to meet these various needs. To do this there must be a competent editorial department to cut, select and catalog. A description of each film must be written, which will completely but briefly and accurately give the information which a customer needs in order to be sure that films meet his purposes. Not only this, but the librarian must be thoroughly in sympathy with the problems of the non-theatrical field.

Nos. 2 and 3—Who are the patrons of a non-theatrical library and what do they want?

The patrons of the non-theatrical library are much the same as those who frequent the best public and reference libraries—the high-school superintendent looking for a clean entertainment for community night or parent-teachers gathering, a physics instructor looking for a graphic demonstration of the gyroscope, a doctor who wishes to find out how some noted surgeon operates on a patient, and with the school man and the doctor comes the Y. M. C. A. secretary, the churchman and even the father and mother for films to help them meet their special problems. The great problem of the father and mother is to get films suitable for the "kiddies." Many films that are entirely satisfactory for adults are not suitable to show to children and yet the theatre production must be made largely for adults. With all non-theatrical leaders the mission is not primarily to entertain but to promote educational, moral and social ideals.

No. 4—Where films for the non-theatrical library are to be found.

Let us state frankly that these demands are now being met only in a limited way. The theatre producer has made some contributions, but in general it is only his by-products that are of most value to the non-theatrical library. In the theatre exchange, the principal offering is the drama. The travel and scientific reels are only incidental and are put in largely as "filler," and when used are interspersed with titles to make them as entertaining as possible. The non-theatrical librarian in general cares nothing for the drama unless it has some special up-lift or literary value, and if he puts in a comedy it is because of its crowd-and-attention-drawing qualities. If there is anything in the comedy or drama which might offend or be misunderstood by the audience, many of whom are children of tender

years, it must be taken out. The titles of the travel and scientific reels must be changed to make them instructive rather than simply spectacular. It is safe to say, however, that the re-edited and re-made films produced originally for theatre use are destined to become a decreasingly small part of the non-theatrical library.

State and government institutions, especially the extension departments of Universities, are contributing some films made especially for the non-theatrical field. The industrial company is doing something in its line, but it is principally the productions of the private enthusiast and private corporation with high ideals and a long range vision to whom the librarian must look for films to meet this special demand.

No. 5 — Difficulties met with in gathering together a non-theatrical library.

The difficulties in the way of increasing a non-theatrical library as rapidly as some would like are many and varied, but the following are some of the principal ones: producers with the exception of one or two have not visualized the possibilities of this field and many of them have looked upon it simply as a dumping ground; the technical man has used the field as a practice field and has sent out productions of the cameraman and director which would have been discarded as early as 1880. Scenes taken in dark places without artificial illumination and actors without even amateur training have been used. In fact, the only ambition of the director in most instances has seemed to be excessive footage.

We know of one film which was made by quite a prominent industrial company which ran 13,000 feet, yet it covered only the production and distribution of a single product. To give you a definite idea of how greatly this film exceeded the necessary length, it was later cut to three reels without loss of any of the essential parts, and it was finally cut to one reel without serious loss. The extension worker, the state department head and the industrial manager, if they have not been the victim of unscrupulous producers, have themselves tried to fill the role of scenario writer, director and cameraman with weird and startling results.

The material furnished to the ordinary theatre has been produced almost entirely from the standpoint of entertainment rather than instruction. As a result, editing is an extremely difficult task. Names of films are found to be exceedingly misleading. For instance, a film entitled "Rip Van Winkle" supposed to follow the theme of Washington Irving's story of the same name, more closely follows the scenario, "Who Paid the Rent for Mrs. Rip Van Winkle," and the title writers in travel films have usually tried to be facetious rather than accurate.

Productions of private corporations are largely in the stock-promotion stage and to say definitely what will come out of this field is extremely difficult, but up to date the only thing that has come out is wild promises in return for perfectly good money of ministers and school teachers. To digress a little, not only is the

money being wasted, but unfortunately there is, as a result, growing up an atmosphere of distrust which is making it extremely difficult for legitimate concerns to finance themselves.

One of the stock statements is this: There are 200,000 churches in the United States and only 15,000 theatres, so that the church field ought to be at least ten times larger than the theatre field, but the writer of the stock prospectus fails to point out that the attendance of the 200,000 churches is little if any more than the attendance of the 15,000 theatres, and therefore, if we assume that all 200,000 churches install motion picture machines, the returns from the rentals to the 200,000 churches would be little if any more than the return from the rentals to the 15,000 theatres. It is hardly necessary to point out that if one had prints enough and office and library force enough to serve 200,000 churches and only received the amount which the theatre exchanges receive for serving 15,000 theatres, the profit from this service would be exceedingly meager if it existed at all, and as we all know, it will be a long time before even a small fraction of these churches are ever supplied with machines.

Another ill-considered statement is that the films will be rented five times per week and shipped from one church to another. This system leads to two serious difficulties. From the standpoint of the user, the serious difficulty is that in nine cases out of ten he does not receive the films when he wants them because after the first church has used the films, there is no one with enough sense of responsibility to see that the films are shipped out and with no central exchange which would be aware when these films were not shipped, the user in general would find himself without films and without even a substitute.

This system, on the other hand, from the standpoint of the library owner, is absolutely fatal as the films if shipped from one church to another would be destroyed in an extremely short time, as a church having used the films would have no particular reason and no facilities to repair and take care of them. The result is that a small tear soon leads to serious damage and there is no place where the old saying, "A stitch in time saves nine," applies as well as in film.

No. 6—Past failures of non-theatrical producers with an outline of some of the causes.

Since the beginning of the non-theatrical field about five companies of importance have attempted the building of a non-theatrical library. Of these, two have failed utterly. A great many reasons could be assigned for their failure, but the principal ones are these: They greatly over-estimated the number of machines actually in use in the non-theatrical field which would run the standard of film which they were distributing, and the distribution of machines to this field progressed much more slowly than they prophesied. Because of the exaggerated idea they had of the possibilities of the field they became easy victims of the sophisticated producr who unloaded upon them worthless productions at exorbitant prices.

Not only this, the producer not realizing that the non-theatrical field is a by-product of his own business, but thinking of it more or less as a competitor, did everything he could to make matters difficult. But probably the most serious reason for failure of these concerns is that neither of them had any intention of doing more than sell stock and as most of the money received from the sale of stock went to the stock salesmen, there was little left to capitalize the film library. Incidently, the rentals were much less than was anticipated. In fact, they were extremely low, 75 cents and $1.00 per reel, $1.50 being a high rental. Not only were the rentals low, but the films wore out much more rapidly than they expected, this being due somewhat to lack of care, but more largely to the type of machines they were using in their exhibition. Machines, especially of the portable and semi-portable type, were made largely by men who did not know and in some instances did not care whether they destroyed films or not, as they had no interest in libraries or exchanges, their principal idea being to produce a machine that was light and compact and apparently reduced the fire hazard. Few of the manufacturers realized the seriousness of shutting up the film in a tight box and subjecting it to high temperature, while grinding it through with a cross loop in a space so narrow that the least carelessness would cause it to rub on some part, and the least failure of the take-up meant almost immediate destruction of the film because it was enclosed in a box out of sight of the operator. Recently this destruction of film has been increased by the placing of tight valves in the magazine. These are of questionable value in preventing a fire from being communicated to the magazine, but there is no question but that they materially shorten the life of the film.

No. 7—Successes obtained in the building of non-theatrical libraries.

The success of the remaining companies in the non-theatrical field has come largely because of the adoption of the Safety Standard by this Society. The Safety Standard has a two-fold benefit, the one making possible a simple, efficient machine that not only does not enclose the film with the lamp but runs with a straight loop, and the other the possibility of forming a library which is a true by-product of the regular theatre exchange. The Safety Standard libraries are a true by-product in that their films will not run on the theatre machines and therefore cannot be rented to theatres or sold in foreign markets in direct competition with the theatre exchange business. Because of this fact, many of the producers have taken a much more liberal stand and have thrown open their vaults to the Safety Standard librarians and have allowed them to select almost at will from their productions. There are now three non-theatrical libraries in existence, one with at least three thousand subjects and with exchanges covering all the principal cities between the Atlantic seaboard and the Mississippi River, another with at least one half that number of subjects, with exchanges along the seaboard and another with plans well under way for placing exchanges throughout the country, espe-

cially in the West. These libraries are obtaining an abundance of satisfactory material, because not only have producers thrown open their vaults, but one or two big producers have turned almost their entire attention to producing films for this special field. The private enthusiast is getting more and more experience in the handling of apparatus and with this experience, the quality of his productions is rapidly improving.

As to the private corporation, although films have been made largely for stock promotion, at least some things that are usable have been produced, and better still, two or three companies are taking hold of the matter as a real permanent business and not simply from the standpoint of stock selling.

The non-theatrical film business has come to stay and is growing rapidly. The people interested in the entertainment field are coming more and more to realize that they cannot stop this development any more than they can stop the flow of the river by erecting a dam and not providing an outlet. They are understanding more clearly that they can direct the current down the sluice-way of the Safety Standard where the power created will light the home, the school and the church without becoming so bright as to dim the splendor of the electric sign of the theatre on the corner.

Discussion of Paper by L. E. Davidson

Mr. Victor: Mr. Chairman, I have held the belief for some time that until money enough can be obtained in rental from the non-theatrical users of motion pictures it is not going to amount to an industry. I have talked to ministers and schoolmen upon the subject of prices for films, and it has been somewhat difficult to convince them that they have to pay almost as much, in the way of rent, for a reel of film, as, say, a third-rate theater—say, $2 per reel.

Nevertheless, it is a certainty that until the day comes when the non-theatrical user of motion pictures is able to pay enough rental for film, it won't pay to produce pictures, and they will be compelled to borrow pictures from the theater and, of course, those pictures are not entirely suitable for the church and school.

Now, we talk about correlating films to the school curriculum. It is a tremendous task to accomplish that, and how many millions it will run into I do not know, but it is a certainty that until the church and school realizes they have to pay for the service from these films, we never can produce the films they want and need, and I think the whole secret of the success of the non-theatrical film rests on that one thing alone—that is, an earning power which will enable us to manufacture the character of film they want.

Mr. Perkins: I just came in to hear this valuable discussion. Perhaps you will be interested in the work we are doing in the Department of Agriculture, which is almost entirely non-theatrical.

The Department of Agriculture, as you know, is a very important department. It is much more widespread and does a great many more things than the ordinary man realizes. It is composed of 14 large bureaus. Public Roads, Weather Bureau, the Forest Service, Animal Industry, Chemistry, States Relation Service, Plant Industry, Soils, Markets, Crop Estimates, Entomology, Biological Survey, Farm Management and Publications.

The Department of Agriculture has about 18,000 people in the field, probably half of whom are doing some sort of extension work or regulatory work. Probably half of the half spoken of have a use for pictures in furthering the work of the Department.

We began making pictures in the Department of Agriculture about seven years ago. We are still making them. We have about 130 subjects now, and have about 800 reels in circulation. We regard the motion picture as a very effective ally in the extension work.

For instance, we recently produced a picture called "Out of the Shadows," showing the relation between animal tuberculosis and human tuberculosis.

About two months ago, this picture was taken to Vermont, and shown before the Vermont State Legislature which was considering whether or not it should appropriate $400,000 to cooperate with the Federal Government in eradicating animal tuberculosis. The picture was shown in the Senate Chamber at the State House, and I have a letter from the inspector in charge there who says that the picture

had a great deal to do with putting over the appropriation in that State.

Today I received another letter that happened to talk of the same picture; he said he had heard many lectures on animal tuberculosis, and that there never had been any questions raised by the audience afterwards, but that he recently saw this picture and afterwards a half-dozen farmers went to the men in charge and asked them how they could have their cattle tested for tuberculosis.

These are merely isolated instances. We have many of them to show that the motion picture is very effective in our work. It is doubly effective for the reason that many of the people the Department tries to reach never have had much to do with motion pictures. Most of them live out in the country where they do not have "movies." We are getting to them by means of the portable projector, largely; sometimes equipped with a generator outfit on a truck; sometimes with a generator on an automobile engine.

The main thing is that we are getting to them, and we are going to do that increasingly in the future.

I haven't any doubt whatever but what the Department of Agriculture is going to continue to use motion pictures for a great many years, probably permanently, in this work.

We want to work just as closely with the commercial end of the game as we can. We don't want to trespass on the commercial man's ground, and we expect him to work with us. We are not making any pictures that will hurt the business of the theatrical man. We make only pictures that apply to the work of the Department of Agriculture in some way. We try to make them as entertaining as we can, but it seems to me the Government should not interfere with the commercial industry by making pictures that will cut down the market for the commercial man's product.

On the other hand, we have an arrangement that some people might construe as interfering with the commercial man's business. We offer prints of our pictures at the manufacturing charge to all distributors, to cooperating state institutions, anybody with a legitimate use for them. We don't care whether he charges admission to see them or not, if he will get Department facts and Department knowledge—that is, Government facts and Government knowledge—before the people. We regard him as a very good ally. If we sell him prints, he can charge to see them, but, of course, we won't guarantee he will have exclusive use. At the same time our free distribution among our own people goes on.

Now, the Government, in a larger sense, is doing a great deal of motion picture work at the present time. It is pretty well scattered. I counted up about a year ago and found there were 17 different organizations in the Government doing motion picture work. I don't know whether you are interested in that subject. If so, I could give you a list of the bureaus and departments doing motion picture work. The Signal Corps of the War Department has millions of feet of negative which 100 years from now, if it lasts that long, will be invaluable. It will be a complete history of

the world war. You can imagine how valuable that would be if you think how much you would prize a print showing George Washington crossing the Delaware, or the surrender of Lee at Appomattox. Those Signal Corps films will be of that value, and of that character, 100 years from now. The Public Health Service is going into films. The Reclamation Service has some films dealing with use of reclaimed land. The Bureau of Mines has its own pictures. The National Park Service has the same. I believe the War College has some. The Bureau of Navigation of the Navy Department has some. The Wark Risk Bureau has one or two films. The Children's Bureau of the Department of Labor has some, and so has the Women's Bureau. The Bureau of Education has a large quantity of films.

In practically all of these cases the films have been produced by commercial companies at a contract price. However, in the case of the Signal Corps and the other divisions of the War Department, those were made by their own photographers.

I am often very much interested in thinking how far the Government ought to go in motion picture. I have no doubt whatever that the Government should make use of the tremendous power of motion pictures to get over things that should be got over. I do not doubt that advances will be made in the future.

We, of course, are very much interested in the non-theatrical field that Mr. Davidson has just been talking about. We find it very advantageous sometimes to show pictures in certain communities and churches and schools. They are very effective allies.

There is nothing more I wish to say, but if anyone has any question I can answer I should be mighty pleased to do what I can. (Applause.)

Mr. Perkins: All the war negatives are in good shape. I was in the Signal Corps laboratory about two weeks ago on some other business, and saw how wonderfully they were taking care of these negatives. That is, the war negatives.

The Signal Corps has photographers who are taking pictures of many things of historic interest around Washington. For instance, the day I was down there they were running off a picture made at the time of the Inauguration of President Harding. That, of course, applies only to the Government end of it. I don't believe they would take pictures of anything that was not strictly governmental.

A bill was introduced in the Congress late in the last session providing that the Government should establish an agency, or authorize an agency now existing, to preserve copies of every film of great interest.

Mr. Perkins: In that bill the agency suggested was the new National Museum, which is part of the Smithsonian Institution.

Mr. Richardson: What means, If any, is the Government taking to preserve films of historic interest? I have had that matter up with the Government myself through the President's office two or three times.

Mr. Perkins: You mean films of historic interest relating to the war?

Mr. Richardson: Relating to anything, what would you give today to see a film of Abraham Lincoln?

Mr. Perkins: A whole lot.

Mr. Richardson: And 100 years from now people will give a lot to see films of Harding and Wilson and things of that character.

Mr. Perkins: All the war negatives are in good shape. I was down there about two weeks ago on some other business, and saw how wonderfully they were taking care of these negatives. That is, the war negatives.

A Member: How long do you think negatives will stay fixed and usable if it is put in good shape and preserved?

Mr. Victor: I think I can answer that. I saw some negatives some time ago of McKinley's Inauguration and Roosevelt's Inauguration, and McKinley's funeral, and some scenes taken before that, and those are about 20 years old, some of them, and they were in perfect condition so far as the emulsion was concerned, but I found, to my intense surprise, the camera work they had in those days was perfectly rotten. (Laughter.)

Mr. Richter: Wasn't the film shrunken pretty badly?

Mr. Victor: Not very much. With a step-printer it didn't make much difference. I printed up about 8 reels of those pictures and some of them were the very earliest made by the Edison Company.

Mr. Richter: I might say that I have had some experience with old negatives, and I find that the celluloid base in some of those old negatives seems to crack and crinkle up and the sprocket holes run right out when you try to run it through the machine. I think there is room for improvement on the part of the chemist here. Camphor, as you know, which was used for the tempering of the nitrate of cellulose, has been replaced. You don't notice the camphor odor so strong in your printing rooms now. That has been replaced by a synthetic substitute for camphor, and it may interest you to know that recent tests show that the rate at which motion picture film burns when this synthetic substitute is used instead of camphor, is less than 50%. In other words, the camphor in the nitrite of cellulose furnished a large part of the combustible properties of the nitrite of cellulose.

That suggests another thing; if a substitute can be used for camphor, and make the film much less inflammable, why could not some additional foreign substance, which will not be of harm, be used that will put the fire out?

Every chemist knows that the trinitrate used for making up this material is not gun-cotton. It has not the high nitrification; it does not contain near oxygen enough to burn with sufficient force.

If they will do this; if they will find substitutes for camphor, which they have, and for these other materials which leaves the film in that brittle condition, the probabilities are that a negative will last very much longer than does the camphor saturated, nitrite of cellulose films last.

Furthermore, if those engaged in research will give their time

and attention to the development of a proper base, nitrite of cellulose, or what not, properly impregnated with the proper chemicals for preservation as well, we cannot only reduce the inflammability, but we can take care of this matter of the future.

Of course the shrinkage of the coating formed by the gelatine and the nitrite of cellulose is something that can be taken care of, provided you keep the humidity off of the place in which it is stored right.

I don't have much confidence in a negative being printable 100 years from now, even if it is printable 20 years from now, on the old chemical basis.

Dr. Mott: That is a matter of chemical reaction. We know that chemical action doubles every time you raise the temperature 15 degrees centigrade. The solution of the whole matter is to keep the film in a freezing temperature. You undoubtedly will be able to keep it for 100 years under those conditions, if you have already kept it twenty.

Mr. Mayer: A hundred years is only a long period relatively speaking. We may want to keep them a great deal longer than that, and I believe we do. I wonder if it is not possible, and probable, that we will come in the near future, to discover some way of duplicating negatives so correctly and clearly that every 25 or 50 years a picture may be transferred into a new negative, and in that way keep the thing in perpetuity, because if you depend on the original negative some day or other, whether it is 100 or 500 years, it is coming to the end of its usefulness.

Submarine Photography

By J. E. Williamson and Carl L. Gregory

ABOUT fifteen years ago the navigation of the air was something looked upon with eyes of doubt all over the world. The first flights of the Wrights were hailed with amazement and the newspapers and magazines were filled with accounts of their achievements. At that time it was regarded as a marvelous thing to reach an altitude of a hundred feet and to maintain a biplane in the air for more than a few minutes.

Still, the air had been conquered. The way had been opened for almost unlimited progress in the development of aerial navigation. The desire of man to fly—a desire that had lurked in his breast since he first observed the birds—was about to be gratified.

Today, it is not uncommon to read of new altitude records being made by airmen who have mounted more than three miles above the earth and of flights that have lasted for hours. Even now preparations are under way for an aerial voyage between the Old World and the New, while there is under contemplation a race between air craft around the world. Only a few years ago the first flight across the English Channel was the sensation of the hour.

How strange it seems that while so much brain toil, financial energy and heroism have been expended in mastering the air, so little has been done toward solving the riddle of the sea. Since man first embarked in craft propelled by brawn the struggle to triumph over the surface of the deep has been relentless, and now we have, plowing the ways at express train speed, giant steel liners nearly 1000 feet long, and carrying enough people to populate the average town. But as they make their way from continent to continent, simply skimming the surface of the oceans, the water goes down beneath them thousands of feet, and this is the part of the ocean that man knows little about.

Except from the lips of divers who have descended on the edges of the coasts to a puny depth of a hundred feet, we are in ignorance of what lies beneath the waves. And the divers, with the limited field of observation accorded them by the crude appliances of their trade, have been able to tell us but little of the nature of things in that vast area beneath the waters which embraces three fourths of the earth's surface. By the weight of a lump of lead on the end of an inanimate wire we have sounded the depths and learned that there are places where the ocean's bottom spreads full five miles beneath the surface. From samples of soil hauled up by mechanical means we know, in a small way, the character of this bottom.

But, could a man have any idea of the beauties of the Yosemite by looking at a handful of gravel in one of its ravines; could he imagine the wonders of the Alps by gazing upon a fragment of rock chipped from some majestic peak and sent to him by parcel post; could he picture the glorious coloring in a tropical garden by seeing the withered leaf of a stately palm?

And now the riddle of the deep is about to be solved.

What the initial flight of the Wrights was to aviation, the experiments just concluded on the ocean's bottom in the Bahama Islands will be to submarine exploration.

For hours at a time men have sat in comfort within six inches of the bottom and fifty or sixty feet beneath the surface. There they have smoked and talked and breathed as naturally as though they were upon the shore. And they looked with ever-widening eyes at the wonders and beauties of subaqueous forests; studied with never ceasing amazement the countless thousands of brightly colored tropical fish; watched with increasing admiration and surprise the panorama afforded by the lacelike length of a coral reef, with hosts of brilliantly hued fish swimming in and out of its pearl caverns, and observed with wonder and awe the skeletons of once proud ships, with backbones and ribs exposed, as they rested where they struck and disappeared from human ken generations ago.

What these men saw beneath the sea they photographed and some of the wonderful pictures they secured are reproduced with this article, giving to the readers of this publication the first authentic views ever taken in the depths of the ocean.

While it is true that the greatest depth achieved in these experiments is not greater than that frequently reached by divers, it was clearly demonstrated that the means for deeper trips into the unknown waters has been found, and that the time is not far distant when it will be easy to go down several hundred feet. The apparatus used in the experiments was subjected to a thorough submarine test and structural analysis at the Norfolk navy yard by officers of the navy, who reported that it would be perfectly safe, in its present form of construction, at a depth of 800 feet. To make it strong enough to go even deeper is simply a mechanical detail.

The experiments in the waters of the Bahamas were made to secure a scientific motion picture film, one that would show the actual conditions on the bottom and the daily life of the many forms of sea life that abound in the waters of the tropics. Before describing the way in which the photographs were secured an outline of the apparatus used will give an insight into the mechanical features of the experiments.

Several years ago Captain C. Williamson of Norfolk began working to perfect an invention that would take the place of the ordinary diving suit. It was his idea that some means should be developed by which a man could go down into the water unhampered by weights and ropes and compressed air and water pressure. His experiments extended over a long time, but finally he was successful and the government granted him a basis patent.

Broadly considered, his apparatus is in three parts; (1) floating vessel of any suitable design; (2) submersible terminal operating chamber in which work or observations can be carried on at the bottom of the water, and (3) a collapsible, flexible tube of metal, connecting the floating vessel and the submersible chamber.

The main feature of the invention is the tube. It is made of

Diver at Work on Wreck, Coral Reef in Background.

steel in sections of varying lengths. Each section is composed of an upper and lower flange and these are connected by a set of steel hinges, so arranged as to open and shut along radial lines to the axis of the tube, but at all times to fit against each other so closely as to be water-tight. Some of the sections have only one set of hinges and when collapsed the flanges rest upon each other. In the longer sections there are several sets of hinges joined to each other between the upper and lower flanges. When collapsed they stand about three feet high; they are eight feet long when extended. The sections can be fitted to each other readily, and by this means the length of the tube is regulated. Because of the collapsible nature of the sections it is possible to submerge the tube. Any one who has tried to push a large bucket bottom downwards into the water will realize what a difficult thing it is to do. With the collapsible tube each section just a little more than displaces its own weight in water at the surface when extended. Therefore, it will sink. But deeper down the pressure of the water overcomes this greater displacement. Then the tube automatically collapses, section by section, from the bottom upwards, and as each section closes its weight remains the same, but its volume of displacement grows less. By this means the continual adding on of sections at the surface forces down the sections below. To the bottom section is fitted the operating chamber.

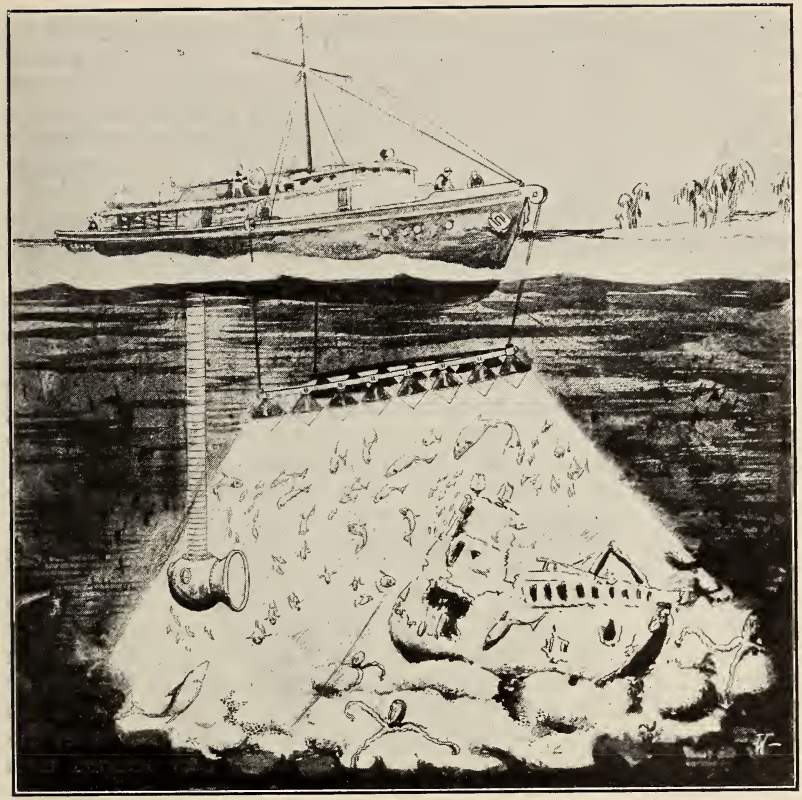
The idea of taking submarine motion pictures came to the sons of the inventor while watching the projection of a scientific film showing fish swimming in a small glass aquarium tank. These two boys, J. Ernest Williamson and his brother George M. Williamson, had worked with their father in the development of the tube ever since they could remember, and while watching this film they got into a discussion over the feasibility of placing a camera in the apparatus and photographing submarine life in its natural haunts and surroundings. They had both often been down in the tube in the waters of Norfolk Harbor and seen fish swimming about as they looked through the glass ports. They did not let the idea rest. The very next day they set about arranging experiments, and in a few weeks had secured excellent snap shots with an ordinary camera, of fish swimming along the bottom of Hampton Roads.

Using these photographs as an argument they formed a corporation in which several of the most prominent business men of Norfolk are stockholders. These men saw the way to put before the outside world views of that portion of its surface that man had never before seen, and realized the wonderful scientific and educational value of a photographic record of the ocean's bottom.

Although conservative bankers, business and professional men who would not be ordinarily impressed by such an unheard of idea, they were so convinced by these photographs of the ultimate success of the idea, that they gave freely of their time and means to finance and outfit the expedition.

How well justified their foresight was is shown by 20,000 ft. of marvelous film taken beneath the ocean in the West Indies.

It is a fitting coincidence that the first successful motion pic-



How submarine movies are made.

tures ever taken beneath the ocean were made at a spot only a few miles from the place where Columbus's ships first dropped anchor in the New World.

The Williamson boys designed a special chamber for the photographic work and also drew the plans for a vessel from which to lower the tube and chamber. This chamber is a hollow sphere of steel with an inside diameter of five feet. From its center a cone of steel five feet long and five feet in diameter at the large end projects horizontally. This cone penetrates the sphere and at its small end, where it is eighteen inches in diameter, a steel bulkhead is fitted. In this bulkhead there are two glass ports, three inches in diameter, and placed one above the other with about five inches between them. They are the eyes for the photographer and the camera. The large end of the cone is closed by a piece of plate glass an inch and one half thick and five feet in diameter. It was manufactured in Germany especially for the purpose and is optically flawless.

To protect this glass from the pressure of the water, gauges

and pumps were installed in the sphere. One gauge showed the water pressure against the outside of the glass. The other showed the air pressure within the cone. The pump was used to keep these two pressures equal. The steel bulkhead at the small end of the cone prevented the compressed air from escaping from the cone into the sphere. In the sphere the air was the same as that above the water. It came down the tube just as air comes down into the hold of a ship and the photographer worked under the same conditions he would have experienced were he photographing the inside of a building.

It was the original intention that the first pictures be taken on the Pacific Coast near Southern California, but upon the advice of Dr. Townsend, curator of the N. Y. Aquarium, who has spent the best part of his life in oceangraphic study all over the world, the Bahama Islands were selected as being richest in varied forms of marine life and variegated coral, and the water of unexcelled clearness at Nassau, N. P., was selected as the central point about which the expedition was to work. Nassau is a splendid winter resort with which American tourists are unfortunately but little acquainted.

Not only are the Marine Gardens there more beautiful than any others in this part of the world, but there are many wrecks strewn along the treacherous coral reefs which extend for thousands of square miles among these islands. Here in the old days many a Spanish galleon and treasure ship, many a Spanish conquistadore and many a rich merchant ship came to grief, and in the lagoons and inlets famous pirates found their refuge—Black Beard, Sir Henry Morgan, the infamous Teach, Captain Kidd, and many another notorious freebooter, beached their boats and scraped their hulls, and sought the wood and water.

Here in later days thrive the beach combers—many of them descendants of these old pirates—none the less savage and avaricious in their greed for ill gotten salvage.

In these clear waters the fish attain the most gorgeous colors and the most beautiful and fantastic forms.

In the shipyard at Nassau the Williamson boys had constructed a vessel suitable for the operation of the chamber. In form this vessel was a barge about forty feet long by eighteen wide. In its bottom an opening was cut large enough to lower the chamber through and this opening was built around with heavy timbers to a height of three feet above the water line, making it a well. Chain hoists, capable of lifting eight tons each, were suspended above the well. One of them was made fast to the large end of the cone and the other was used to lift and lower the tube, being attached to the upper flange of the topmost section by a steel yoke. A collar of timber and steel was built across the well. This collar could be fitted close around the upper flange of the top section when it was desired to disengage the yoke and add another section of tube.

The Williamson brothers had charge of the entire outfit—its preparation, construction and operation. They secured Carl L. Gregory, regarded as being one of the most expert photographers

in the country, to make the first photographic film ever taken beneath the ocean, and to these three young men is due the wonderful success of the undertaking.

Photographing under water through water is something new. Density and light values had to be studied carefully to avoid improper exposure and faulty focus. Besides, the problem of finding good "locations" was a troublesome one. Prior to starting work with the camera Mr. Gregory and the writer cruised around the waters near Nassau, carefully scanning the bottom through plates of glass inserted in the bottom of their boat. Whenever a spot of unusual beauty was seen it was buoyed. So were the old wrecks that could be discerned resting against the very reefs that destroyed the fine ships they once were. The prettiest stretches of coral reefs were similarly marked and so were several deep caves in the bottom that were the abodes for thousands of brightly colored fish.

With this preparatory work completed the barge, loaded with the chamber and a hundred feet of tube, was taken in tow by a powerboat and actual photographic work began.

The first film was made in the celebrated Marine Gardens at a depth varying from fifteen to twenty-five feet, according to the surface of the bottom. These gardens are in a narrow strait between the eastern end of Hog Island and the western end of Athol Island, and through this strait there is always a very strong current running estimated at about seven knots an hour. It was just the place to give the tube a severe test at the very beginning of the work and the result was eminently satisfactory. By mooring the barge to four anchors across the tide and then slacking the cables on one side and taking in those on the other, it was possible to let it swing with the tide. While it was swinging, Mr. Gregory, down in the chamber, turned the crank of his camera and photographed a panorama of sea bottom, wonderful in the luxuriant growth that makes the Marine Gardens so beautiful and unlike anything that can be found above the surface of the waters. The clearness of the water and the perfect illumination afforded by the sunlight coming through it and striking the white coral bottom was remarkable. In the deep recesses of coral caverns it was not at all unusual to secure perfectly exposed negatives at 1/75 of a second with a lens opening of f6.3.

The barge was named the Jules Verne, in honor of the writer whose imagination saw what the camera has now taken for the whole world to see, and it was a strange coincident that the powerboat that towed it was named the Nautilus. Superstitious ones in the party at once decided it to be a good omen and Colonial Governor Haddon-Smith of the Bahamas was struck by the two names the day he came out to the barge to go down in the tube and take a first look at some of the territory over which he presides. He was amazed by the beauty of the spectacle revealed and would not be contended until Lady Haddon-Smith, who accompanied him, also went down. Captain Haddon-Smith of the English army and his wife, and Colonial Secretary Hart-Bennett also were in the party, and so was American Consul Doty. They all took turns in descending into the

chamber and were loathe to leave the beautiful view that was unfolded before their eyes.

In looking down through the water by means of a water-glass the vegetation in the sea gardens is much foreshortened and the greatest height is, seemingly, about three feet. Through the glass of the chamber, however, all of this foreshortening is lost and the beautiful ferns, sea palms and others species of subaqueous growth are seen in the full dignity of their real height. Looking at them from the bottom they wave and sway in the tide to a height of eight or ten feet.

Nearly every one who has toured in tropical waters has seen the native black boys dive for coins. One of the most interesting of the films is that which shows these boys while they are beneath the surface fighting each other for the elusive bit of silver. Sometimes three of them were caught at once struggling to get the piece of money at a depth of twenty-five feet. A very remarkable photograph was taken at a speed of 1/300 of a second and caught one of these divers at the instant his head and shoulders appeared beneath the surface when he was diving.

For the first time in the world photographs were taken of deep sea diver working on a wreck. Near Nassau there is the bulk of an old blockade runner that came to grief while seeking safety in that harbor during the Civil War. She lies at a depth of fifty feet and scattered on the bottom near her are some rust-encrusted cannon and many cannon balls. George Williamson volunteered to be a diver and a suit was borrowed from the Colonial government. Although he had never been beneath the surface in this sort of garb before, Mr. Williamson gamely went down and strolled about the wreck, picking up cannon balls and sending them aloft in a wire basket attached to a line. While he was so engaged Mr. Gregory, safe and dry in the chamber, was photographing him.

Another very interesting film was made to show the entire workings of the sponge industry. The fleet of a hundred or more sponge schooners was filmed at the quay in Nassau. Then the barge was towed out to the sponge bottoms and the chamber lowered where a full view of the sponges could be had. Instead of diving, the spongers use a bucket with a glass bottom, which they look through into the water. When they see a sponge they push down a long pole with two iron hooks on its end, twist the hooks into the roots of the sponge and pull it from its bed on the bottom. This process was photographed, both below the water and on the deck of the sponge boat. Then the marketing and trimming of the sponges was filmed on shore.

Many, many feet of film were made of the hundreds of different kinds of fish that abound in the Bahama waters. Some were caught as they swam about in their natural haunts among the coral reefs and others, by means of a baited line were drawn close up to the chamber. Color plates were taken to be used as a guide in coloring the film by hand so that the world may see in their natural tints the fish, the wrecks, the reefs and the marine gardens. Also these plates

will afford an authentic record of what was seen on the first step toward robbing the sea of its secrets.

As in all tropical waters the sea around the Bahamas abounds in sharks and a film that has no counterpart in the annals of photography was secured of a battle between two of these monsters. Specimens 18 ft. and 20 ft. long are common and no ordinary sized bait would last long enough for the purpose of photographing them.

After, however, unwinding many miles of British red tape, for the law does not permit an animal to be wantonly killed no matter how incapable of work it may be, a lame horse was secured and put to death by a special agent from the Police Department, at a convenient place on the shore from whence it was towed out to sea, and anchored in the water near the apparatus. The carcass was slashed with a knife so that the blood might flow out on the outgoing tide, and in less than an hour after there were 20 to 25 of these huge fish milling around the bait. They are the natural scavengers of the sea, but some instinct seemed to tell them that the carcass anchored there augured no good for them, but they swam around and around it several at a time and swallowed eagerly huge chunks of meat which were thrown overboard from the barge.

The crew caught half a dozen of these monsters with large hooks attached to chains. After losing several hooks which were used with heavy woven wire, but which snapped between their serrated teeth like pack threads, one of the largest of these freshly hooked monsters was drawn close to the chamber to permit the taking of a good view of his Leviathan struggles. A portion of the hunch of meat which was used for bait still protruded from his jaws and while he struggled thus, another huge shark swam in view and wrested it from his jaws. He swallowed it at one gulp and seemed infuriated that there was no more. He swerved about like an angry bull, swam away for a few feet, then turned and with open jaws darted like an arrow at the fish still imprisoned by the hook. He snatched at one of the huge fins and tore it to shreds in his razor like teeth. The imprisoned animal, which had not struggled much at the hook up to now, became infuriated. Appalled at the danger of the man in the chamber, for should one of these huge animals have struck the glass at full tilt it would certainly have been broken and the operator drowned beneath the deluge of tons of water, the men on deck slackened away on the line and the two huge animals engaged in battle royal, each plunging toward the other with wide opened mouth, tearing one another at every available point, each bite tearing the flesh and streaming blood, and finally despite the hook which still hung tenaciously to his jaws the wonded shark beat off the other one.

All of this is faithfully recorded in the film up to the last moment when the vanquished shark swam bleeding away and the other churned the water into foam, battling with the barbed death in its mouth.

There have been many fish films taken in tanks at aquariums. and from the surface, but the tank has never been built that could

stage the spectacle made by those sharks. The ocean is their home, their hunting ground and their battle field, and to photograph them you must go to them in their own domain. Many stories have been written of hand-to-hand conflicts with man-eating sharks, but when it comes to finding a native diver who will actually go down armed with nothing but a short knife and engage in a single-handed combat with one of these brutes, it means considerable more effort than an exercise of a fertile imagination with a pencil and paper. Such a man was at last found, and motion pictures made of a naked diver meeting one of these kings of the deep in his own element, and with a long sweeping stroke of his keen knife disemboweling an immense shark who darts toward him with open mouth, escapes the yawning jaws as a matador dodges a bull, and with one swift thrust of quivering steel lands a death stroke in the monster's vitals.

Address by Mr. Henry D. Hubbard of the National Bureau of Standards at the Washington Meeting of the Society of Motion Picture Engineers, May 9-12, 1921.

"THE MOTION PICTURES OF TOMORROW"

MR. HUBBARD: It is a real pleasure to hear and meet with a group of men who are doing things so well worth while in so important a field as yours. The fact that I am an outsider in a sense fits me to speak on the motion pictures of tomorrow, for it is really true that hints may arise naturally outside which would not as easily develop from within. When I was invited to speak to you I promised to set aside the technical difficulties to be encountered and take a long look ahead remembering that time is purely relative and our vision of 1950 may come whenever we are ready to make it true. Certainly we must agree with Mr. Jenkins that the motion picture is destined to be, perhaps, the greatest industry of the world.

It has been said that the time will come when we shall think of nothing but education. The necessity for most of our manual toil will vanish when we have automatic power machines for every task, but education will be the great occupation, for all of us will teach and learn—learn new truths by original research and discovery or inspired thinking, and teach the newly gained truth. Some of us feel very strongly that in this future learning and teaching the motion picture will be the great factor, and largely displace the printing press for graphic, vivid, dynamic education.

Now Motion Picture Engineering is a new field, an important field, and it is not necessary to fix its limits. Some years ago I had the pleasure to witness the formation of the Illuminating Engineers Society which now numbers thousands of members. Before that time there were few real illuminating engineers. A physicist of a University might perhaps be consulted as to a given system of lighting, but he naturally knew little of the many practical problems of illuminating engineering. He knew the laws of light and optical instruments, but this great field was scarcely recognized as a profession and its scope was undefined. How did this field of illuminating engineering take form and scope as a profession. The case is analogous to your own. In the year 1910 a committee arranged a comprehensive course of technical lectures on various phases of illuminating engineering. The lectures were given in Baltimore and then published in two volumes which promptly were recognized as the foundations of the subject, and at once established it as a great profession. Within a short time the Society had more than a thousand members. A similar course would doubtless help to establish the profession of motion picture engineering and to make this Society one of the great engineering societies of the world in numbers and in power as it is today in interest.

May I now proceed to the subject of my address: "The Motion Pictures of the Future," in deference to the forward vision which close attention to present-day details is apt to obscure, but which

stimulates and inspires if our interest is genuine. Some of the things I may have to say will doubtless sound impractical, but you and I know that in 1950 we may be ashamed of any expectations formulated today. I have tried to keep within bounds and be conservative, but no man can be conservative in the motion picture field with technical developments coming as they are today.

Motion picture engineering is emerging as a profession of power and vision. The motion picture engineer is master of the materials, devices, energy, and ideas which equip the motion picture art to portray any real or ideal scene which nature gives or the mind of man conceives. The field of motion picture engineering is a circle having a well-defined center but no circumference. It is worth while to survey its central function and its farther reaches. Its primary function is to create mechanism to record and project pictures made dynamic and alive by a timed sequence which is the soul of motion picture engineering. The ideals of the inventive engineer will make the motion picture art of tomorrow, for that art has no limitation other than the creative imagination of the artist and the technical resources of the motion picture engineer. Nor can we overlook his further function which concerns the studio, the theatre, auxiliary mechanism, lights, incidental appeals to the senses, and finally the subject matter of the pictures, for the subjects give direction to his efforts and in turn are enriched by new devices.

What of the future? Shall we ignore it? We cannot, for our labor is all for the future. Is it possible we are working for a future we do not see, for an outcome we do not know, toys of caprice of predestiny, or can we master our fate? Human evolution has two extraordinary results: the steady emergence of man's power to know the cosmos and assimilate the experience of all men, and the steady rise of man's control of his own future making it independent of his heredity, his past, and his environment. We are freer to make destiny than ever before, freer to control nature and today we have the knowledge, the materials, mechanisms, and energy, and will to plan our own future. Science predicts. That is its chief function and its power. The engineer uses such predictions and makes programs which become a prophecy which he makes come true. So you see it is not so much prophecy we need as it is a program. I seek chiefly to stir your own vision of a future bright with achievements in your field, to foresee not what is coming, but rather what you are to bring. So it is for you to make the program for the year 1950 and this is my thought in this talk on "The Motion Pictures of Tomorrow."

It is possible to make continuous and rapid progress if for all new knowledge we could establish direct channels from all the sciences to every motion picture engineer so that all new data may be made instantly available for use in your field. Is this possible? It is certainly possible and I feel that it is inevitable. In the sciences an extraordinary thing has happened this century. The splitting up of human activities into minute specialties has not prevented it. The

cause is the avalanche of new data resulting from new research and technical experience. The result is that no specialist can keep up with new knowledge even in his own field. The case is becoming steadily more serious as new data multiply at a faster rate. What are we to do? We shall be driven to do what the new education teaches that we ought to do—namely, to stop making our brains mere store houses for facts. The brain is too valuable for that.

The brain is the organ of action, not of fact storage. Yet such data are the basis of all your progress. When we had few telephones we had no directory; today we print them all in a-b-c order in a directory and can find any number in a few seconds. We must make all technical facts accessible for instant use. Our dictionary is a beginning. With a half million words in our language, we can find any word and its meaning in half a minute because it is arranged for that purpose. We must apply that idea for existing knowledge, and to the deluge of new knowledge, priceless but overwhelming. Our system of knowledge is breaking down and a new system is called for, to objectivize such data, externalize our memory, as we have extended our eye and ear. Then for the first time our brain will be used as an organ of action which the phychologists are recognizing as its true function. The ideal is simple. To make all existing and new knowledge available for instant use by any technical expert, as handy and accessible as his purse or his pocketknife. We must move toward that ideal and when it is reached progress will be quickened to a rate we do not dream of today.

It is a very old idea that progress comes both by steady improvements, and also by jumps—in biology called mutations. Mechanical inventions come by mutations. In the art of communication the speaking trumpet came first. The speaking tube was a device of a new kind—a pipe line for speech. The telephone displaced the empty tube by solid metal wire. Finally the radio telephone is a new art by which one voice may talk with the whole world through space. Invention as the ultimate art will survive when all industry becomes automatic and power-driven and all men are freed from the struggle for bread and the tyranny of needless toil and free to choose new constructive work. We must expect new kinds of arts during the coming quarter century. Invention, or the design of the automatic power machine, will be the big business for years to come.

Now why in working on any device can we not begin with a theoretically ideal specification. Day-dream the ultimate perfected device, then bring it down to earth modified as little as possible. Insist especially that it be automatic, power-driven, and operable continuously on call so that the operator may become an observer rather than a worker.

I think we all foresee the trend of projector design—we shall soon have the individual projector by which every one may observe any film at his own desk or library table. An individual projector may use a thinner film with small pictures, so that one may use the projector as he uses a book or pencil, slip it into his pocket, carry it with him for use anywhere. Our home libraries will be equipped

to exhibit pictures, as easily as we play a Victrola. Such devices are already available, and will evolve into the animated newspaper of tomorrow. Public libraries of course will have individual screens and projectors for each reader and great collections of highly specialized films on every conceivable topic.

The motion picture engineer is concerned with the total effect on the audience. The limit of your field is your vision and your opportunity, and you create both. Just one or two casual thoughts on the theatre, suggestive rather than definitive. The form of the theatre may receive radical treatment. Today's crowding resembles the days of unregulated street traffic. We may establish one-way aisles and apply every other device of traffic management to ensure easy entrance and exit. Hats and wraps must be cared for by some perfect system not yet devised. Seats must be designed by correct-posture experts for perfect comfort and health, with two independent chair arms for each person. The seats will of course fold automatically as soon as vacated to allow easy exit. Coin-operated vending machines will dispense disks which in turn will operate easy-working turn-stiles according to seat location, eliminating both the box office and the ticket takers. A tiny lamp would light showing for each row that seats were available, the color indicating the number vacant, thus largely replacing the usher. The keynote is the word "automatic."

The theatre size will range from the "little theatres" to the huge theatres for master-productions. The little theatres with lower magnifications will be better for highly specialized films requiring perfect definition. Little theatres will also be suitable for innovations which must meet the challenge of popular taste before being assimilated into appreciated art. At the other extreme we may have vast circular theatres with concentric circles of seats facing the center where each sector will be provided with its own screen and projector all operating with one film. Many times the present crowds could be served and all the advantages of large-scale production would obtain.

Five years ago I was privileged to suggest to you the possible complete control of indoor climate within the theatre. My belief has strengthened that this great step is strictly within the reach of present-day technology, both as to data and mechanism. We cool the air for the dead cattle of the stockyards, why not for the hot and tired thousands in need of refreshment and recreation? We govern humidity for spinning cotton, why not also for making happy lives? We control pressure of air in caissons and altitude chambers for industrial tasks, why not for the highest art, promoting human well-being? Within the theatre we might have the perfect climate, the most exhilarating possible while outside the rain, the heat, the humidity, or the cold might be excessive. This would require conformity to every item of the specification of each type of agreeable climate desired, expressed in units of measure and therefore reproducible. The engineer could control at the optimum value every item such as cooling or heating, drying the air, increasing the air pressure

or decreasing it, adding the healthful touch of ozone, ensuring air purity by filtering or by labyrinths of mercury arcs to give the ultraviolet radiation adequate, atomizing the essences of perfumes such as the odor of the pinewoods, the tang of the sea, the fragrance of the flowers, or "the spicy odors of Araby." All of these elements are today separately realized in actual service and need but the unifying hand of the engineer to realize in combination. This would make the theatre most attractive at all times since we could duplicate the finest climates of the most famous resorts of the world. What this complete control and ideal atmosphere within the theatre will mean for public health and comfort and enjoyment can hardly be overestimated. The incidental possibility is here opened to create a new art, namely to use all of such controllage conditions within the theatre to add the climatic suggestions appropriate to the action of the play exactly as now we add the appropriate incidental sounds and music. This is strictly within the field of the motion picture engineer who is concerned with all the arts and crafts which affect the net result of the art which he serves.

I look to see a phenomenal rise in the art of incidental sounds, includings music, the human voice, and those characteristic noises like the clatter of hoofs, chug of the motor, patter of rain, sighing of the wind, crackling of the fire, and the splash and roar of the sea. Such sounds, if perfectly rendered, add intensity to the realism of the film, but their production must be made automatic and independent of the direct use of a hundred separate noise makers. It is not so much volume as enunciation and accuracy of imitation. Acoustic science will analyze all needed sounds so that their recorded sound wave curves, suitably engraved, may automatically and with high precision produce the exact sounds called for. Their sequence, intensity, and synchronism with the film will be controlled by perforated rolls or punched cards or both. Such cards now control all textile looms for figured weaves, and the automatic accounting and stitistical tabulation in modern plants. The making of such sounds, true to nature, will be an art comparable in importance with that of the incidental music and speaking voice, and will contribute a factor essential to perfect realism in the motion picture art.

The psychologist, composer, and physicist will join in devising new kinds of incidental music and sounds for each play, so that with every action the effective emotional background will be supplied. The orchestra will of course not be present. The artists will execute the incidental music once for all and so perfectly that it will compare with the film, and will be produced on the same basis of automaticity and synchronism by perfected mechanical means. The motion picture engineer will here be vitally concerned.

I look to see perfect and automatic rendering of the human voice audible to every observer of the picture. Only the crudest beginning is yet in evidence. Speaking parts will be added to the silent drama which today is open to the criticism that the characters are seen speaking but cannot be heard. The modern drama with its play of wit as well as action demands the spoken parts, but they

may not be spoken from the stage since amplification and distance distort the finer overtones which are essential to perfect enunciation. At lower amplitudes we may hope for more nearly perfect speech rendering but the defective sounds such as s, f, zh, may require artificial modification in the recorded speech curves. Wireless music and telephone are already here. We can provide telephones by which auditors with defective hearing may clearly hear the speaker on the platform. All the master sounds—music, speech, and noises incidental to the story may be produced in the acoustic laboratory of the theatre adjoining the projection room, and be delivered automatically in synchronism by direct connection with the film movement. Each auditor will receive, if he so desires, the music, speech, and sounds by perfected telephone attached to the back of his seat. The standard adjustment could be gaged as to quality and intensity so that for the average ear the sounds are true to nature and subject to volume regulation by each patron. As such mechanism is perfected, it will be less and less in evidence, just as the lamps are concealed in modern lighting and the projector is relegated to a room outside the auditorium. Eventually only the effects will be perceived.

In motion pictures all skilled movements of hand, foot, or body may be speeded up, slowed down, or transformed, selected, blended, and reproduced before everyone who desires it, an unparalleled adjunct to education, or rather a new pedagogy. Can we imagine a collation by slow-motion pictures of all the skill of the world in arts, crafts, sports, and other bodily motions? The startling fact that experts and champions do not know the secret of their own skill makes them helpless to impart it. The skill dies with them . The motion picture knows no such limitation. It can record by the slow motion camera-projector combination and reveal the secret of such high skill, and can impart that skill to the whole world, the film repeating the movement as often as needed and at the optimum learning speed. Such films may be multiplied until all can learn the highest skill attained by man in any or many lines desired. Motion analysis and high speed cameras can do more. A hundred masters may contribute to a single skilled art, the best elements being selected and combined on the screen in one picture, a consummate model excelling any skill yet attained by man.

May I point out, purely as examples of countless applications, one or two easy next steps in motion pictures composite of instructor, college, and textbook. Take two very popular and common arts, dancing and the piano. Project moving footprints from below on a ground glass floor showing the steps of a given dance. The pupil follows the steps with his feet regulating the movement from slow to normal as skill developes. The same film which projects the footprints may also give a life-size picture of a skilled dancer executing the same step in exact time with the moving footprints, or slightly in advance of them, the picture turning so as to follow the turns of the dancer and remain in view. From time to time helpful hints in print could be included as part of the film projection, giving the perfect evolution by the shadow footsteps. The complete system would

thus be a unified instruction by diagram, picture, instruction, and music all in perfect synchronism, and all selected as the most skilled rendering available.

Apply the motion picture to piano self-instruction. Project above and along the keyboard from one side of the piano a motion picture of the master pianist's hand, showing his fingers executing, say, the chromatic scale. A plane or concave glass plate set at 45 degrees forms a kind of camera lucida which reflects the picture to the pupil's eyes. He can thus with his own fingers follow the master's hand and every setting and stroke of each finger, and every turnin of the thumb. The silent phantom of the master's hand, the immortalized skill, would be better than the presence of the master himself and far less disconcerting, for with joined ends the film could patiently repeat the motion as often as needed, and at any speed, steadily faster as skill developed. Likewise every difficult bit of technic could be taught by masters whose movements would be recorded as we now record their music. The engineer must design simple and suitable projectors for the purpose, as easy to operate as a metronome, and a set of instruction films must be prepared by masters of their art.

Similar films will be used for teaching the skill of all arts, in handling tools, manipulating materials, in sports and other daily activities, where skill or economy of effort are of concern. It it too much to hope that we shall begin at once a complete program for making available to all human beings perfect models of all skilled motions. This would mean a new era in education, a new art of pedagogy. Self-education thus made possible may solve the inadequacy of schools and teaching staff to instruct the population of the entire world.

Can you picture the realization of this ideal through the motion picture? Surely, thirty years of determined research by you gentlemen can easily make this possible, and it could be as much less as our vision and effort is increased. With a true vision of the importance to the world of this achievement we could accomplish it in a very few years. The motion picture would then be the supreme habit educator of the race, new and more excellent models being developed summing up the experience of the world, so that no new skill is lost, and our children may all begin at the highest point of skill yet or anywhere attained.

A unique merit of the motion picture which will make it of supreme value is that every individual who has an idea to give forth can himself prepare the master negative in his own home—a power not inherent in any other universal means of disseminating new knowledge. Some day the camera in the home will be the most important means of preparing new knowledge for dissemination to the world. Can we imagine what a thousand future men like the French Fabre could do with the hundreds of thousands of insects and other forms of life, each with a life history of fascinating interest. Multiply the same possibility by all fields of human interest and research and some vision may be possible of the contributions which will

slowly distil in countless homes for the enlightenment and entertainment of mankind.

What of the motion picture camera of the future? Thinking of the year 1950, or before, as we will, may we give for a moment free play to our imagination and fancy the specifications for the camera of 1950? Dare we expect a camera with automatic focusing, automatic aperture adjustment, a camera recording in full color, with bivisual stereoscopic effect, developing the picture instantly, telegraphing the pictures, exactly as recorded, automatically to be filed, and with mechanism for instantly locating any film without index, and exhibiting it immediately; a camera with self-sensitizing plates on which not separate pictures but a continuously changing picture is formed and erased after being telegraphed to the storage room; a camera equipped with mechanism for automobile cleaning of the glass surfaces, and the whole not to exceed in size the smallest kodak of today.

For fear such a camera may be declared impossible, I hasten to remind you that Mother Nature anticipated my specification by some million years when she gave us our two eyes. The result is that each of us has such a pair of cameras, self-directing, self-focusing, and self-cleaning, the exposed surfaces being cleanser twenty times every minute. These wonderful eye cameras ar not made with hands but they have automatic aperture adjustment, sensitize and develop their own plates instantly, taking colored pictures in full motion, stereoscopic pictures, telegraphing them exactly as recorded to the optic lobes of the brain subject to instant recall in our little theatres of the mind. The cameras are portable, not larger than the smallest vest pocket camera of today. The plates are concave, the lenses always in focus, giving a wide angle image of more than 180 degrees. The camera is guaranteed to work continuously sixteen hours a day for three score years and ten and with care will give excellent service for twenty or thirty years longer. These cameras are equipped with self-renewing plates on each of which three processes—sensitizing, development, and erasure—are continuous and simultaneous. Mother Nature as an inventor has done some unpatented miracles and has no copyright on the designs.

Now here we have a real motion picture program for 1950. Nature has set us a splendid goal and blazed the way to that goal when she gave us our two eyes. Dare we predict or plan that the motion picture engineer shall perfect such a motion picture camera according to Mother Nature's specifications? Why should we not? Mother Nature has already done it, and has given us the model. We outstrip Nature in many ways. We can fly better and faster than the bird, outswim the fish, outspeed the deer, with mechanism of our own devising. Our telescope and microscope vastly excel the eye in seeing the distant and the small. Our camera prints may be duplicated in material form, those of the eye can not. Again the eye must see at once or not at all, but in the camera the effect of light is cumulative. In photographing the stars, each additional second exposure brings new and farther distant stars into range, so that

twelve hours exposure records stars we may never hope to see. Nevertheless the specification of Nature's marvellous cameras and projectors offers a wonderful program for the next quarter century or less, one which will attract the inventive genius of many engineers.

May I predict that in education, in diffusing new knowledge, in visualizing the results and methods of industry, exploration, research, in entertainment, in stirring men to high ideals, the motion picture will prove man's greatest single power. More interesting than the printing press and its art, more eloquent and intelligible than the spoken word, more effective in many ways than our chance contact with life itself. Its mission, already great, knows no natural bounds and has possibilities of which as yet we dare not dream.

Washington, D. C., May 9, 1921.

New Developments in Mazda Lamp Projection for Motion Pictures

By C. A. B. Halvorson, Jr.

PROBABLY no field of illumination thus far invaded by the incandescent lamp presents more difficult or exacting requirements and diversified problems than that of professional motion picture projection.

The relatively low intrinsic brilliancy, an inherent characteristic of the tungsten filament, constitutes a handicap at the very beginning which, however, is more than offset by its other exceptionally useful characteristics, such as:

1—Adaptability to alternating current circuits.
2—Steadiness.
3—Economy of operation.
4—Ease of control and operation.
5—Cleanliness.
6—Healthfulness—due to the absence of carbon dust and poisonous or injurious gases.
7—Continuous uniformity of screen illumination.
8—Absence of flicker.
9—Less glare and eye fatigue due in part to the warmer color of light.

These are some of the reasons why the Mazda Motion Picture Projector lamp has become a big factor in the field of the professional

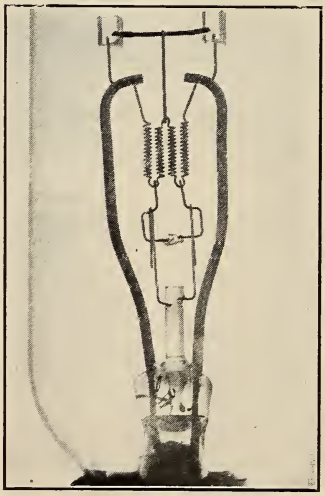


Fig. 1. Mazda C Motion Picture Projector Lamp.

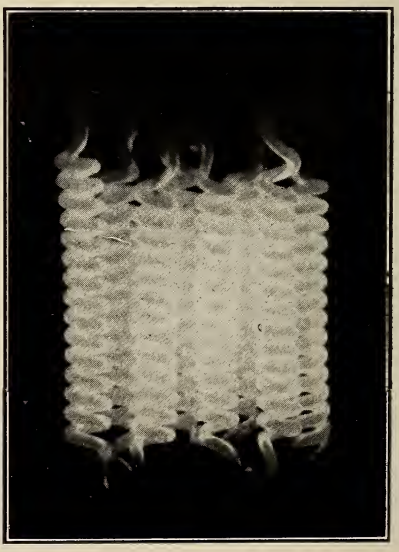


Fig. 2. Image Coils Correctly Meshed with Filament Coils.

projection of motion pictures and is being used more and more in even the largest theaters.

Mazda C Motion Picture Projector Lamp. Tests have shown that with the present commercial optical systems available for motion picture projection, a light source of about 0.4 inch square sides or a solid area of approximately 0.16 sq. in. is required to obtain the best results. If the coils of the filament are coiled parallel to each other and are positioned in a plane perpendicular to the optical axis, and if the spaces between the coils are filled in with the images of the coils produced by a spherical mirror, then a light source will be obtained which will be both uniform and efficient. (Fig. 1.)

The useful life of the lamp is determined by the quality of the picture in the screen—this depending upon the quantity of light and the evenness or appearance of the screen. It is obvious, therefore, in order to conform to these conditions, that the filament coils must maintain their initial relation or position to each other, that is to say,

Fig. 3. Warped and Distorted Filament Showing Impossibility of Properly Meshing Image with Filament.

the coils must remain parallel, so that the image cast by the mirror will mesh in between the coils of the filament and produce an apparent uniformly lighted light source. (Fig. 2.)

When the development of the lamp was started, the filament was naturally positioned above the main supports. If this construction be operated continuously over a long period, there will not appear any change or distortion in the relation of the coils to each other. However in actual professional motion picture theater practice, the lamp is operated intermittently, or in other words, lighted for half an hour, cooled for half an hour, and so on. Under these conditions, trouble arose, the coils twisted, warped and distorted making it impossible to correctly mesh in the image (Fig. 3), resulting in a streaky non-uniformly illuminated screen and consequent loss of light—since the light source was no longer of a solid area but was full of holes and a good part of the filament lay outside its original confines.

Mr. R. S. Burnap of the Edison Lamp Works of the General

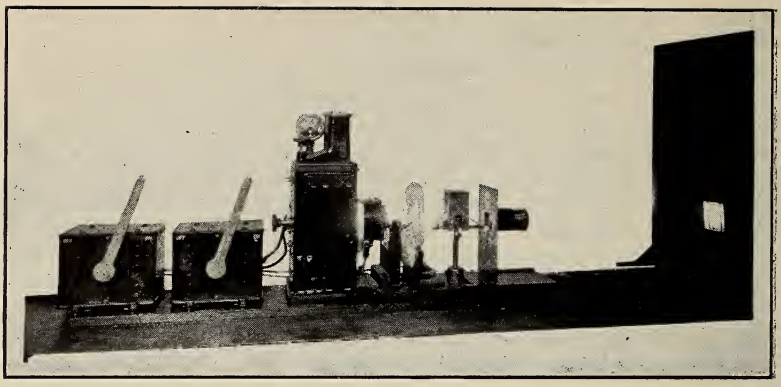


Fig. 4. Apparatus Designed at Lynn for Studying the Functioning of Lamp Filament.

Electric Company suggested projecting the filament on a screen in order to facilitate the study of the action of the filament during heating and cooling (Fig. 4). The filament, having a high resistance, will heat up almost instantaneously as can be seen by studying the curves in Fig. 5, which shows the thermal expansion of the present standard commercial filament construction. When the current is turned on, the tungsten filament heats rapidly and the lower part "A" expands downward almost instantaneously in its only free direction to point "a" on curve "A" and then gradually is raised above its starting position by the slow upward expansion of the supports,

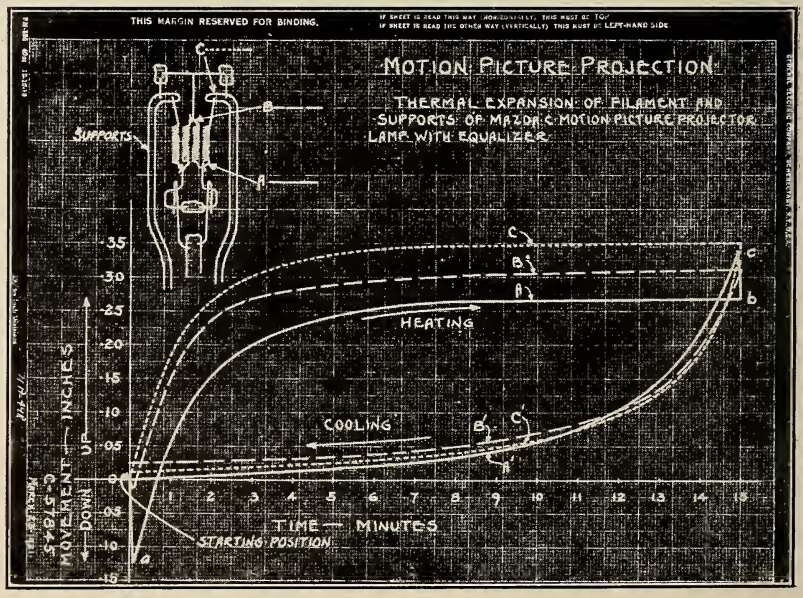


Fig. 5. Thermal Expansion of Mazda C Motion Picture Projector Lamp.

to point "b". When the current is shut off the filament cools almost instantaneously causing a contraction and a still further upward movement beyond its hot operating position to point "c". It then gradually cools and returns to its normal starting position along curve "A" as the supports more slowly contract. The expansion of two other important points are shown in a similar manner in curves "B", "C", "B^1" and "C^1". In the old type of lamp, however, on account of the method of support, a condition of compression and tension was formed which caused a distorting and warping which was cumulative in its effect. The type of lamp however shown in Figs. 1 and 5, will burn intermittently over a long period of time without changing the general screen results. In the development of this lamp, many types of constructions were experimented with and tried out. At first, the supports were strengthened then spring top hook supports were tried, but it was found that they would not withstand the contraction due to the cooling of the filament. Another type had compensating springs which illustrated the principle and actually burned over long periods of operation, but could not be produced commercially. At another stage of the development, it was thought that the filament should be held rigidly, but all lamps of this class distorted rapidly and burned out.

At last an equalizer type of construction was experimentally produced and the first types functioned properly when operated in a vertical position, but unfortunately these lamps in professional projection are operated in an inclined position at angles from 10 to 25 degrees. This tilt was sufficient to cause twisting and resulted in a "clutching" effect as the filament expanded and contracted, finally resulting in either an elongating or compressing of the coils or both, and consequently a poorly illuminated screen. These troubles have now been overcome by the construction shown in Fig. 1.

It may be noticed that the glass bulb is tubular in shape and has been so designed that nearly all of the blackening or deposit takes place in the upper part of the bulb where it does not effect the useful light from the filament. This blackening or discoloration is due to the evaporation of the tungsten wire which is deposited on the glass bulb and is the cause of a false impression doubtless created by the blackening of the ordinary incandescent lamps in domestic use. When Mazda lamps are operated at constant voltage (as in our homes), the light grows dimmer as the lamps blacken, but when they are operated at constant current, as in the case of the Mazda C Motion Picture Projector Lamps, the opposite is true, since, as the tungsten evaporates, the wire becomes smaller in diameter, runs at a higher temperature (the same current passing through it) and therefore emits more light. This increase in light more than compensates for any decrease due to the blackening of the bulb, actual tests showing 2-5% more flux at the end of useful life than initially.

Condensing Systems

Now that we have a satisfactory light source of given dimensions, the next question of importance arises as to what type of condensing system is the best or should be used and why.

There are two distinct systems in professional use at present—the one utilizing a single prismatic condensing lens and the other, two plano-convex condensing lenses.

The first prismatic condenser to be used was 3½″ in diameter with 2″ and 5″ conjugate foci—together with a 4½″ diameter spherical reflector, and should be used with the 600 watt 20 ampere Mazda C Motion Picture Projector Lamp only. The 900 watt 30 ampere Mazda C Motion Picture Projector Lamp (now more universally employed than the 600 watt 20 ampere Mazda lamp) uses a 4-7/16″ diameter, white, heat-resisting glass prismatic condensing lens having 2½″ and 6½″ conjugate foci together with a spherical mirror 5¼″ in diameter, 3⅜″ O.R.C.

The Plano-Convex Condensers as used with the Mazda lamps employ the same arrangements and combinations as in arc lamp practice, but should be placed closer to the aperture to obtain the maximum amount of light (see "Condenser Lenses for Theater Motion Picture Equipments," by C. E. Egeler). Unfortunately most of the devices using this system with Mazda lamps retain approximately the standard arc distances of aperture to condenser. This is undoubtedly due to the necessity in many theaters for using the device for stereopticon projection. It should be understood that stereopticon projection with the prismatic condenser is impracticable due to the presence of the image of the condenser on the screen thereby destroying the effectiveness of the picture and consequently in this case means must be provided for substituting a suitable condensing system for this purpose.

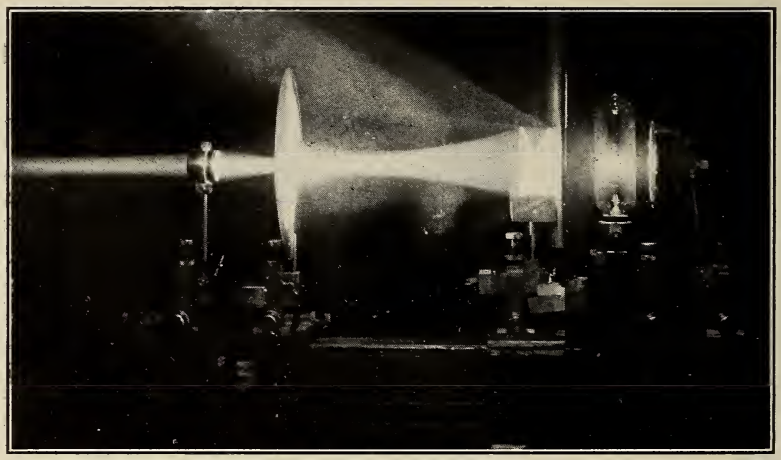


Fig. 6. Light Beam in Motion Picture Projection using Plano-convex Condensers and No. 1 Objective Lens.

Now in regard to the efficiency of the two systems for Motion Picture Projection:

Since the condensing lens is placed nearer to the Mazda lamp in the prismatic condensing lens system, it obviously gathers more light

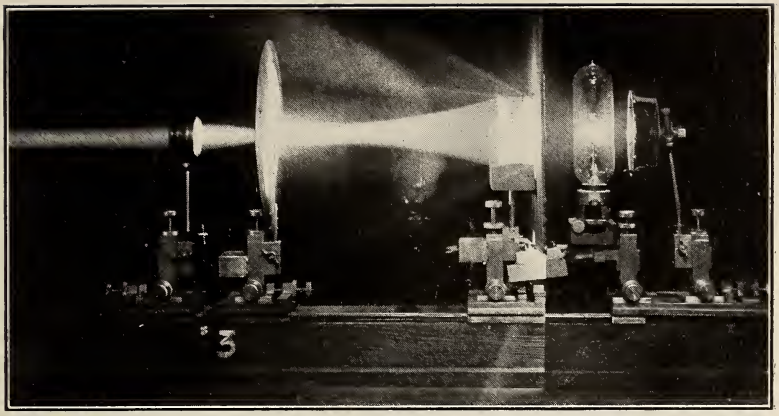


Fig. 7. Light Beam in Motion Picture Projection using Plano-convex Condensers and No. 2 Objective Lens.

rays than the plano-convex condensing lens system, which is placed at a greater distance. Therefore the initial utilization of the light with the prismatic condensing lens system must be greater. On account of the closer spacing of the prismatic condensing lens to the aperture, the light rays pass through the aperture in a wider spherical angle than when plano-convex condensing lenses are used. Figures 6, 7, 8, 9, illustrate the above statements very well. This will account for the greater additional amount of light that can be gained by selecting the correct size of objective lens. By using a No. 2 objective lens (2½″ diam.) in place of a No. 1 objective lens (1⅝″ diam.), when the prismatic condensing lens is employed, an increase of from 50% to 80% in screen illumination may be obtained (Fig.

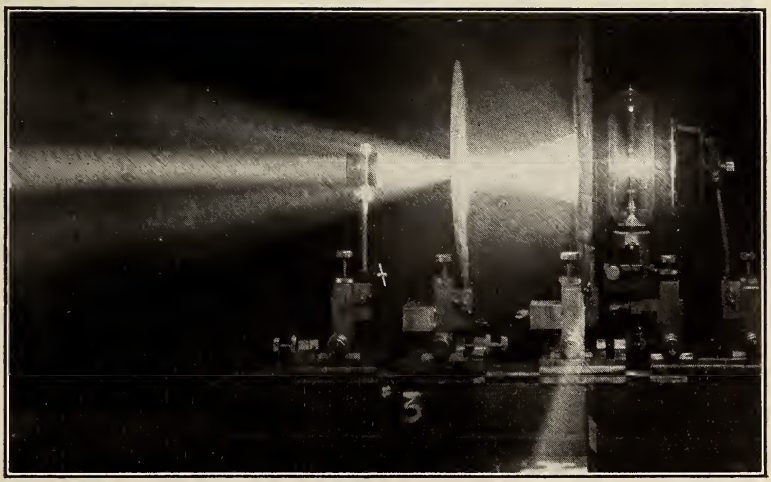


Fig. 8. Light Beam in Motion Picture Projection using Prismatic Condenser and No. 1 Objective Lens (showing light lost with small diam. objective).

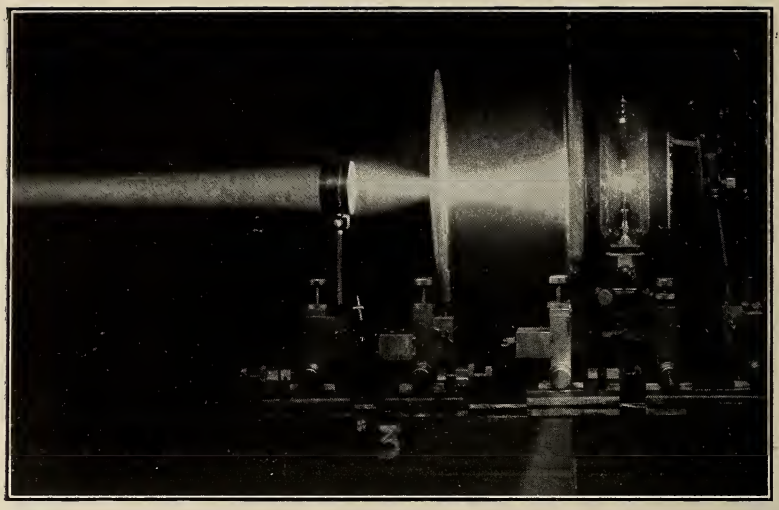


Fig. 9. Light Beam in Motion Picture Projection using Prismatic Condenser and No. 2 Objective Lens (showing full utilization of light with large diam. objective).

10), whereas a smaller increase is generally obtained when using the plano-convex condensing lenses with the same objective lens. In addition, due to the fact that the prismatic condensing lens is pressed and its surfaces are not polished and ground, images of the filament do not appear on the screen (light and dark streaks), so that the maximum amount of light obtained with the prismatic condenser is permissible, whereas with the plano-convex condensers the maximum amount has to be decreased in order to eliminate the images of the filament on the screen.

In the case of the plano-convex condensing lens, when the filament is placed at the position for maximum screen illumination, enlarged images of the filament usually appear on the screen (causing a streaky field) or chromatic aberration is present giving various colors over the screen. In order to overcome either or both of these disadvantages caused in part by the accuracy of grinding, the high polish, and the design of the condensers, the light source must be moved closer to the condensers thereby enlarging the size of the spot on the aperture plate and consequently decreasing the amount of light upon the screen.

With the prismatic condensing lens, however, due to the peculiar design, etc., chromatic aberration is not apparent, thereby allowing the maximum light to be used. Further, the illumination on the screen is much more uniform and does not show the image of the filament.

Tests made show that for maximum light there is not much difference between the prismatic and the plano-convex condensing lens systems—only about 5% in favor of the prismatic, but a few practical reasons for using the prismatic condenser are as follows:

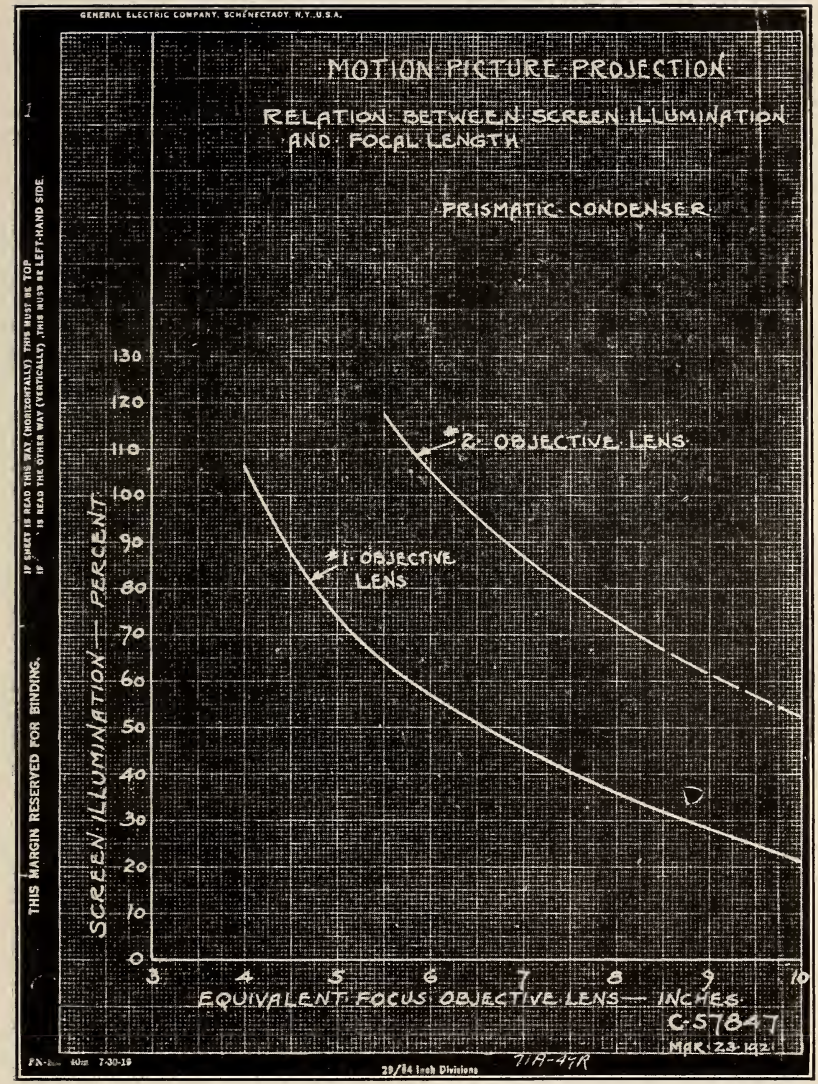


Fig. 10. Relation between Screen Illumination and Focal Length.

1—Maximum light is permissible on screen with the prismatic condenser, whereas it is not with the plano-convex condenser.

2—Easier to get accurate set-up.

3—No chromatic aberration.

4—More uniform screen illumination.

Tests are being carried on with new designs of condensing lenses, some of which make available 20-25% more screen illumination than is now commercially obtainable.

Apparatus and Equipment

The design of suitable equipment (Fig. 11) for use with the Mazda C Motion Picture Projector Lamp presented some rather interesting problems. The requirements of such devices, in order to be utilized in connection with existing projecting machines are as follows:

1—Universal adaptability to various standard makes of machines.

2—Means for lantern slide projection and motion picture projection with the same unit.

3—Proper mounting and placing of lamp controlling ammeters, regulators, etc., in order to secure maximum protection to the lamp and to insure maximum screen illumination when operated at the rating of the lamp.

4—Means to facilitate the renewal and accurate positioning of the lamp so as to obtain maximum results on the screen.

5—A method of operation which would appeal to the projec-

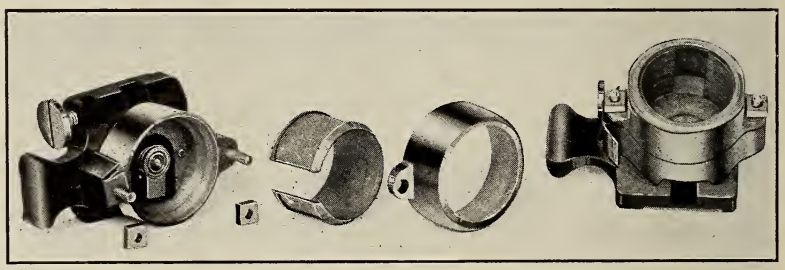


Fig. 12. Lamp Socket for Use with Mazda Motion Picture Projector Lamp

tionist and at the same time meet with the lamp requirements and not take away the projectionists individuality.

The importance of a proper housing with adequate ventilation and adjustments for the Mazda C Motion Picture Projector Lamp is appreciated by very few people. For instance, if sufficient ventilation is not provided, the lamp will become overheated, resulting in a softening of the glass bulb, or a shortening of the life of the filament, due to the higher temperature at which it operates, and a depreciation in the reflecting value of the spherical mirror. Cooling by means of radiation has been attempted, but so far has not been as successful as cooling by ventilation. In the matter of ventilation of housings, many tests have been made with different length chimneys and by this means the draft can be controlled to such a degree that the filament temperature can actually be lowered so much as to considerably reduce the screen illumination.

Early in this development, it was found that with a satisfactory lamp, we were, so to speak, "all dressed up and nowhere to go," for there was no way of getting the lamp into its correct position in the optical systems except by experiment. A lamp setter was then de-

vised (Fig 11), together with a universal adjustable socket (Fig. 12) by means of which lamps can be pre-set, accurately, cold, and days before being used, so that they can be put into a given lamp house one after the other with the knowledge that the filament will be in its correct optical position, vertically, laterally and longitudinally and that maximum screen illumination will be obtained. It is in these little details that Mazda lamp projection has been made a success. A number of devices have been designed to insert in existing arc lamp houses and mechanisms, but it is impossible to obtain the nicety of adjustment with these devices necessary for satisfactory projection.

Means must also be provided for raising or lowering the con-

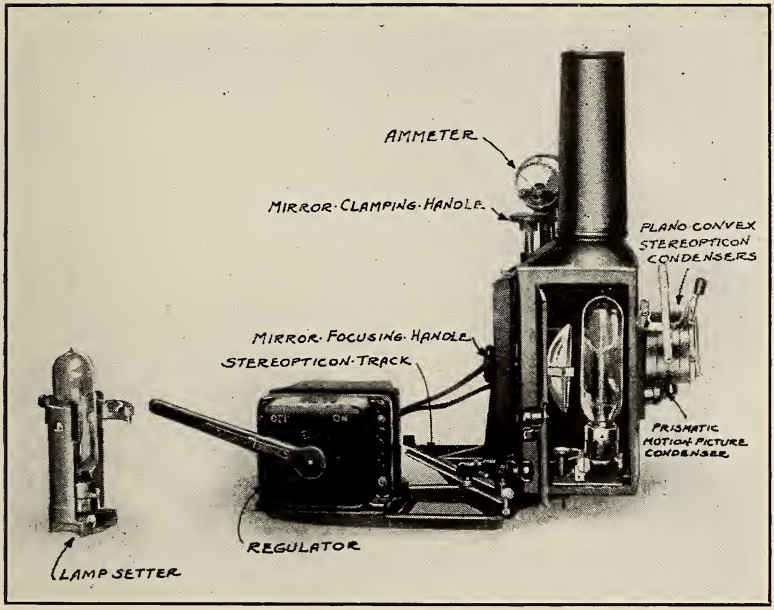


Fig. 11. Mazda Motion Picture Projector Lamp Unit Complete with Lamp Setter

densing lenses or the housing with respect to the aperture plate. This latter is necessary due to inaccuracies which may occur in quantity production of machines and housings. This adjustment has been overlooked in certain designs of apparatus and in more than one device has been the direct cause of an unsuccessful Mazda Motion Picture Projector Lamp Installation. Furthermore, the focusing adjustments must be simple, accurate and positive.

Another most important adjustment is to be found in the mirror support. A very simple scheme for universally adjusting the mirror was devised; namely, a small ball and a split clamp. The member carrying the mirror is threaded through the ball so that the mirror can be drawn back and forth and, in fact, every conceivable setting can be made and the ball clamped with one setting. Such a universal

adjustment is of the utmost importance in forming the filament coil images of the exact size of the projected filament coils. Figure 2 and Figure 13.

In designing a satisfactory projection device, we have been very careful to make sure that the light we have gained by these rather costly methods shall be conserved and in lantern slide projection we advocate the use of an additional plano-convex condenser system. By this means we are always sure that the condenser used for motion picture projection will be free from the lantern slide holder. A lantern slide holder absorbs 30% of the light. However, in the device shown in Figure 11, where both prismatic and plano condenser systems are provided, a track juts out from the base casting

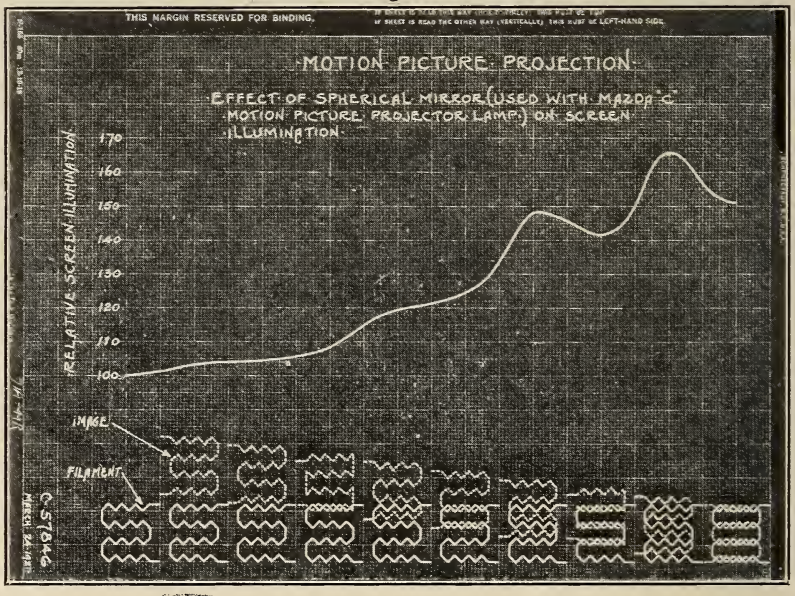


Fig. 13. Effect of Spherical Mirror on Screen Illumination.

on which the housing is slidibly mounted in such a manner that the correct distance is provided when the plano-convex system is used for the projection of lantern slides and when the prismatic condenser is used for the projection of motion pictures the housing can be run back to the 6½″ setting between aperture and condenser face. By this means we make sure that the full value of the lamp is utilized when used for motion picture projection.

In the case of arc lamp installations, instruments such as ammeters, etc., have either been absolutely lacking or placed on a switchboard over on the wall away from the machine and in many cases never looked at by the projectionist, as a few amperes one way or the other made but little difference in the operation of the arc. On the other hand, with the Mazda Motion Picture Projector Lamp,

a few amperes rise may mean the sudden burning out of the filament and always a shortening of the useful life of the lamp, so it is of the utmost importance that the current be kept at the lamp's rated value. The most practical place for the position of the ammeter and regulating device is on the machine where the projectionist can observe and maintain correct current values at all times. This was not fully appreciated at first, and consequently following custom, regulators and compensarcs were located on a wall, away from the machine. Although these devices had means for raising and lowering the current slowly, it was much more convenient in starting and stopping to use the switch on the machine rather than that on the regulator. Therefore, the lamps were usually thrown on at full operating current—resulting in a great overload on the cold filament—the surge amounting to 60-80 amperes. This meant a shortening of the useful life of the lamp, put more strain on the filament and tended more toward warping and distorting with the added danger of sudden burnout upon starting. By designing a regulator to attach no the machine base (Fig. 11), within easy reach of the projectionist, a great step forward was taken. It might be added here that except on direct current, Mazda Motion Picture Projector Lamps seldom burn out during the projection of a picture—this burning out usually occurring immediately after the current is turned on, thereby affording time and opportunity for replacement without interruption of the picture. This is made possible by having a slow starting current which makes the initial surge from 20-45 amperes, from which point it can be slowly brought up to its rated value of 30 amperes, in the case of the 30 ampere 900 watt lamp.

This brings up the question of controlling apparatus—which is best, hand regulators or constant current transformers? Life tests on lamps actually show harder service from the constant current transformers than from the hand regulators due, no doubt, in part to the initial over-shooting of the current. This, of course, is very serious. Constant Current transformers have been made overcoming this objection, but still there arise other disadvantages. Suppose a dense film is giving a 100% perfect picture on a screen and the next reel is an animated cartoon. With a constant current transformer the projectionist is allowed no leeway—no individuality, no way of showing or proving that he is a projectionist of the first-class. The constant current transformer keeps on at its steady predetermined current regardless of the effect upon the audience. On the other hand, however, the projectionist with the hand regulator reduces the current when the animated cartoon is projected, so as to keep about the same brilliancy of screen for his audience, thus overcoming eyestrain caused by too much light (glare). This, (i. e., glare) is the worst condition which we, as Motion Picture Engineers, have to combat. The average person (particularly the theater manager) thinks that eyestrain is only possible from too weakly illuminated pictures, whereas too much light has a far more injurious and lasting effect. The discomforter, however, is usually laid to flicker, unsteadiness, etc., which are aggravated and more pronounced with higher illumination.

Shutters

The ordinary two-wing shutter obstructs about 40-50% of the total light and many experiments have been made with the object in view of reducing this loss without producing flicker or without a loss of brilliancy of the picture. It is true that the angular width of the shutter blade can be reduced a little below the actual amount of effect. The discomfort, however, is usually laid to flicker, unmotion of the film, that is, the lens may be partially uncovered when the film starts to move and also may have been partially uncovered before the film quite stops its motion. Whatever is done, however, in this direction results in a slightly reduced brilliancy or contrast on the screen although an increase may be made in the amount of light.

Numerous experiments have been made in the direction of rendering one or the other blade more or less transparent or translucent. The net result in each case is to increase the screen illumination at the cost of the contrast and brilliancy of the picture. In the same way transparent colored sectors have been used, but no advantage has been obtained. If any light is transmitted through the film and objective to the screen while the film is in motion it must of necessity result in blurring the picture or reducing contrast.

On the other hand, if the movement of the film can be confined to a smaller fraction of the cycle the shutter blade can be made smaller and a saving made in light lost. To do this requires that the film be started quicker, moved at a higher rate of speed and then brought to rest quicker. The practical limit in this direction will be determined by the strength of the film itself.

The proper position at which to place the shutter in front of the lens has also received considerable attention. While but little difference can be observed on the screen with different positions of shutter it can be said in general that the best place for the shutter in the case of the prismatic condensing lens system is close to the lens.

Exploitation

The prevailing tendency today in motion picture projection is to over-illuminate the screen to such an extent that that part of the audience paying the highest price for its tickets usually receives such a high intensity of illumination from the screen that the glare causes eye fatigue and much discomfort arises.

In the past, installations have been made only in small theaters with short throws and small pictures—satisfactory pictures having been readily projected in these instances, even though only 50% of the available illumination was being used.

With the beginning of the Fall of 1920, however, installations were made in several large theaters of 1,000 seats and over—the installations being made from an engineering standpoint as nearly correct as possible, this including possibly a change in EF of objective lens, a change in diameter of objective lens and in some cases a change of the screen surface.

Taking New England for example, out of a record of 58 theaters the maximum throw is 121 feet, minimum 50 feet, and average 75

feet with maximum width of picture of 17 feet and average of 14 feet. Of these theaters, 25% have reflecting types of screens and 75% diffusing types. Of these theaters, the average seating capacity is 775 with a maximum of 2,000 (seven of them over 1,000). There were direct current arcs in 25% of them ranging from 40 to 75 amperes and 60 ampere alternating current arcs in 75%.

In some parts of the country conditions at present are not suited for incandescent projection as in other parts, due to the large pictures, 18-24 feet in width, being shown. As soon as owners and managers learn that better pictures, better projection, etc., can be obtained by reducing the size of pictures in these cases and decreasing the amount of illumination on the screen in many other instances, thereby eleminating glare and eyestrain (whether with arc or incandescent), then will better projection be obtained.

Discussion of Paper by C. A. B. Halvorson

Mr. Dennington: Mr. Halvorson brought out some very interesting points in his paper, not only in regard to some of the difficulties that have been met and overcome in the construction of the lamp, and also in the application of this lamp for projection purposes, but there was one point on which it seemed to me he might have gone a little further. Mr. Halvorson showed the adjusting mechanism of the mirror, but it would seem that the mirror might be fixed in position, just as the condenser, leaving only the light sources movable.

The use of an incandescent light source has advantages which the general public has been very slow to recognize fully. The fact that this light source when once placed in position remains fixed, is one of the features that has not been fully appreciated, because all of the mechanism which has been on the market has had adjustments.

Now, there probably has been in the past a very good reason for these adjustments, because they were absolutely necessary with any light source which moved its position from time to time as the electrodes burned away. With an incandescent source which remains fixed, that is not absolutely necessary, and a permanent adjustment of the light source is possible and advisable.

I have in a number of instances mentioned this possibility before this Society, and it would seem that we are getting at least one very simple application of the plan, and I think it can be carried further. There are other applications which are outside of the regular projection field, in which the scheme can be adopted—searchlights, floodlights, may be mentioned, merely as examples, where the light source could be preadjusted, placed in the reflector or other optical system in the correct position, and that will enable closer regulation to be made than has been possible where the adjustment is left up to the individual.

I want to ask Mr. Halvorson a question with reference to the inner and outer filament of the coil of the lamp. He mentioned the inner coil as being hotter than the outer. Does that make any difference, or does it cause a non-uniform screen distribution of light, by having that effect, a hotter inner coil than outer?

Mr. Halvorson: I don't think it would affect it much one way or another.

Mr. Kunzman: You haven't made any experiments on that, have you?

Mr. Halvorson: It would be less than the regular increase. The range in temperature, the ratio, maximum to minimum, would be very much lower than it would be in the case of any other luminant. However, there is a difference there—in that particular case, the inside coils are under tension, whereas the outside coils are supported, and there is a double action in there. The outside coils were closing up, the inside ones dropping down.

Mr. Halvorson: Mr. Dennington spoke about mounting mirrors in a non-adjustable manner. That has been tried. We machined up

the facings of the lamp houses, i. e., we started in to build a "precision" lamp house. If the job is really to be done right we should start in with the lamp, locate the filament with reference to the axis of the base, etc., and make the filament itself with less than 2/1000 of an inch variation from the draftsman's design. To make such a lamp would be very expensive and the cost of such a lamp would be all out of proportion to the cost of a lamp made and turned out cheaply by multiple process machines as at present. In addition, the mirrors themselves vary. The outside radius of curvature will remain the same, but the distance from the opening of the mirror to the center of curvature may vary. When speaking of mirrors, I wish to say that the Bausch & Lomb people have done everything possible to make Mazda lamp projection a success. When we undertook the development of the proposition, the life of a mirror was 30 hours or less. Today the life of a mirror is unknown, due in part to improved ventilation and to the new type of silvered back developed by Bausch & Lomb which is a wonderful development.

There is 8-10% loss on the cooling plates that can be corrected for by filing out the cooling plate aperture so as to accommodate the wide angle of light used with the present prismatic condensing system. In addition to light being lost here, there is actually a shadow cast on the screen by the edges. Another thing, Figure 10 shows a difference of 100% in the No. 1 lens from 4"—6" E.F. and 75% in the No. 2 lens from 5½"—8½" E.F. Why can't the lens manufacturers straighten these curves out so that there will be no difference?

The shutter obstructs 50% of the light. Faster intermittents will help this (we have transmitted 85% of the light experimentally without flicker or wear to the film) and also there is the continuous moving film such as Mr. Jenkins has developed. Then again a change in screen design may also help to increase its brilliancy.

There is an installation in this city, in a medium-sized theater. It was put in three weeks ago in anticipation of this meeting. I thought that possibly you, gentlemen, would like to see a typical installation representative of this development. It is at Crandall's Knickerbocker, at 18th and Columbia Road, in an 1,800 seat house.

A member: What is the throw?

Mr. Halvorson: 108 feet, with a 16 foot picture.

What has been so far accomplished represents only the first step in the development of the incandescent lamp for this class of work. Hundreds of these equipments have been tried out quietly as commercial experiments in order to get information on the lamps, etc. In New England alone, there are over 250 equipments operating in theaters of all sizes and conditions, many of them have been installed for over a year. We are still a long way from the melting point of tungsten. By raising the current to 33-35 amperes the illumination on the screen can be increased 60-125%. Of course, this would mean a short life lamp, but it is not ridiculous to talk about a 25-hour life or even a two-hour lamp. It is also possible to obtain 50% more light with a special condenser system. It has been done experimentally and we will do it some time commercially.

Talk and Demonstration Action of Various Chemicals on Arc Lamp Cores

DR. W. R. MOTT

Mr. Mott: Gentlemen, I came down here and brought a lot of rubbish with me, so that you could have a little picture of what happens when you put chemicals in the arc.

There are a large number of chemicals you can put in the arc and every one you put in, something different happens, and the number of different combinations and the number of physical phenomena and varieties of changes in the arc are simply enormous.

I have written on the board a definition of "arc," which I have published, and which I think is a pretty good working basis for a starting point. It is: "An arc is a column of very hot light conducting gas, carrying a current sustaining this condition."

A spark does not have the sustaining condition.

(At this point Mr. Mott demonstrated by means of the blackboard, and also by means of shadowgraphs the action of various chemicals on the arc.)

The Chairman: We have had this very interesting analysis of the research work on chemical action on carbon arcs, and I am sure it is going to be a valuable addition to our Transactions.

The meeting will now be open to a discussion or any questions.

Mr. Mayer: I want to ask Mr. Mott what is the effect in the white flame arc, on D. C. when the negative electrode is similar to the positive?

Mr. Mott: In reply to Mr. Mayer's question, if you have a flame positive and, say, 25, 30 or 40 amperes, the flame material moves naturally to the negative. At 150 amperes, it may not. The negative carbon does not contain flame material, and the upper carbon would not contribute any to efficiency, but if the negative carbon is the lower carbon, we have the currents of air—then, by putting the negative carbon in the lower, at 25 or 30 or 40 amperes or less, the flame material will feed to some extent to that lower carbon and lend a high efficiency to the arc, about as high, under some conditions, as if you had positive lower, and if you had a positive lower the use of the flame negative adds neither to or subtracts from the arc.

I recommend for aperture and studio lighting that both carbons should always be flame carbons for the reason that 90% of the complaints has been due to the fact that the wrong polarity was used. That only applies to lamps of 20, 25 and 30 amperes.

Also, another reason is if you want to use a lamp on alternating current, 2-flame carbons are going to give you much more light than one. Did I answer your question entirely?

Mr. Mayer: Except I am not quite clear whether you mean to imply the light is increased by the use of flame carbons top and bottom, or whether it is simply a mechanical convenience.

Mr. Mott: If the upper is a positive carbon and a flame carbon, and the lower is a negative carbon, the efficiency is increased, perhaps, 15, 20 or 30% by the use of a flame lower. If the lower carbon

is a positive, then an upper flame carbon hardly, if at all, contributes to any increase in efficiency. It depends on how the polarity is. If you take the thing broadly and under all conditions, a negative flame lower is the more efficient and a more serviceable arrangement than the other way around.

Mr. McNab: I noticed in the list of uses that the arc is put to there was mention made of an arc used in motion picture printing.

Mr. Mott: That is the one that fell down.

Mr. Mayer: I think I can help Dr. Mott out on that very subject. He said it fell down, but I do know of an instance where it was done up to a short time ago, and then was discontinued because of the shutting down of the laboratory. That was at the old Gaumont plant, where they matched up their negatives, irrespective of the subject, then shot through their positive print against an electric arc, maintained steadily, and their rate of printing was probably fifty times more rapid than the average rate. The only difference was that the subsequently finished positive had to be patched up, but the rate of printing was much greater, although the subsequent loss of time in cutting and splicing the negative was so great that it overcame that. However, that has been used by Gaumont for years.

Mr. Mott: Of those fifteen uses that I suggested, it is of peculiar significance to note that anly one of them had been proposed at the time I brought the matter up ten years ago. Some time after we developed the white flame carbon, for the photo-engraving line, I suggested that the motion picture people ought to be interested in it, and our salesmen after a number of efforts—first, they said there was nothing much doing with the studios in New York, but finally in the Edison studio they put in some of these white flame carbons in the old rheostat lamps, and they said, "That is just what we want." Since then there have been about 20 companies taking up this problem for various applications—one for blue-printing—and there are various others.

Mr. Kunzmann: I would like to have Mr. Mott say a few words as to the possibility of the high intensity arc, on candlepower, the percentage of increase in candlepower, as compared with the carbon arc lamp 100 amperes, D. C., as used in the largest theaters throughout the country.

Mr. Mott: Referring to Mr. Kunzmann's question, you all know of the paper that Mr. Bassett gave last fall, and that gives plenty of data, showing that you increase the efficiency more than double by the use of the white-flame arc for projection, and so far as the searchlight field goes, both Mr. Halvorson and Mr. Bassett are far better informed on candlepowers than I am, and they will tell you the intrinsic brilliancy is increased about three times, more or less, depending on circumstances. The intrinsic brilliancy is three times that of the carbon lamp, and very close to the sun itself, with the sun supposed to be around five or six thousand degrees centigrade. Then, that acts in combination with the mirror, and gives probably a ten-fold increase in the density of the light you can send out in a certain narrow beam, that is commercially usable. So, you

increase the efficiency from a searchlight standpoint, probably ten-fold, I would say.

Mr. Halvorson: The final gain was about three times. It was, as you have said, about ten-fold over the old 200 ampere plain carbon arc using 2″ carbons, but after the new means of steadying plain carbon arcs was developed, that is, the magnetic control used in the open type cartridge mechanism searchlight and the diameter of the carbons reduced to 1⅛″. I think the net gain in intensity was something less than three times.

Mr. Campe: I would like to ask Mr. Mott if there is not a tendency with the improper selection of the carbon, to give a very high amperage, considerably more than is needed. In other words, there seems to be some demand for from 125 to 200 amperes for projection work. I happened to hear of a case in New York, probably one of the second largest theaters as to size of screen and length of throw, in which they are getting a good picture with 75 amperes, after a careful selection of the carbons. I wondered if there wasn't something in the proper of selection of carbons, which would decrease the high amperage that has been demanded.

Mr. Mott: Why, the efficiency of an arc for projection increases in a rather curious curve, which is roughly like this (indicating on blackboard). First, let us take a curve for the light produced by the arc. That takes a sloping characteristic something like that (indicating on blackboard). Then, your optical system has a characteristtic of light transmission and goes something like this (indicating on blackboard). The sines of these two groups produce a curve very much like that (indicating). It will depend upon your choice of optical system.

I think with 6½-inch condensers, roughly, we find, going from 100 amperes to 125 amperes increases the efficiency of the light 10 to 20%, whereas down here a very small change in amperage increases the efficiency very greatly. Going from 50 to 75, or 75 to 100. If you get beyond 100, unless you revise your optical system, you don't get much gain in intensity, but by adopting the new high tension projecting power, you can drop down here (indicating) and increase your efficiency two or three times, as you well know.

That refers to direct current. On alternating current we have another situation that is rather interesting. Suppose we call that 60 amperes there (illustrating on blackboard). Our curve will come up something like that, and then it will begin to go off on the neutral carbon something like that. Now, we use our white flame alternating current projector carbon, and we get a different type of curve altogether. We get a curve that comes up something like that (indicating on blackboard), so that we can increase the amperage to 100 amperes on A. C. and get a very good gain in screen illumination.

That is something for you people who make projector lamps A. C. apparatus to think about; the possibility of increasing the amperage a little bit on A. C. and getting to the larger size carbons with the new development, and increasing your efficiency 50% with only 15% amperes more.

Mr. Bassett: The subject of high intensity arcs has been mentioned. We all saw Mr. Mott's arc images on the screen. There were no signs of high intensity effects apparent. In other words, no matter how complicated the chemicals were in the carbons, we still have a further complication to that of varying the chemicals, and that is the varying amperage. If we should take any of those arcs as shown on the screen and started to increase the current, the arc itself would vary as we built up the current, and by the time we got up to 75 amperes or 100 amperes, we would have effects which in no way appeared in the small current which was shown on the screen. It is when we get to working in this large current field that we run into the high intensity phenomena which Mr. Mott mentioned this morning, and it is in this field of high current only that we can reach these tremendous intrinsic brilliancies.

I have made a few experiments to see if there was a limit to the intrinsic brilliancy that could be produced by the high intensity arc, and by forcing an arc way above where it would be practical to operate it, I have obtained intrinsic brilliancies which ran over 1200 candlepower per square millimeter, as against the brilliancy of the ordinary carbon arc crater of about 150. In other words, eight times the intrinsic brilliancy of the carbon arc can be obtained by high intensity means. But such excessive brilliancies cannot yet be practically produced.

Mr. Mayer: In speaking of the high intensity effect of highly refractory materials, I was just curious to know at how low an amperage these effects are obtainable, because I figure that the high intensity effect is due to the superheating of the carbon points, and that the temperature at the points depends entirely upon the current density, or the amount of current crowded into a small area. If it were possible to get down to a low amperage, it might open a new field for experimental work.

Have you any idea how low a current with a proportional sized carbon may be used for the obtaining of these effects?

Mr. Mott: Mr. Bassett is fully informed on those things. It is very difficult to answer what limit might be set. We know we can get it at 50 amperes. As to how much lower it can be carried, that is a question for study and experimentation. It is very hard to crowd the current density up on a small point and get the energy density necessary if you get down to low amperage. At 25 amperes I doubt if you could see the high intensity effect. It would possibly remain there in some subtle form, but I mean in an intense way.

Mr. Mayer: But, does the high intensity effect depend on reaching the fusing point of this high refractory material?

Mr. Mott: No, it depends on reaching the high intensity point in the cup. If you will look at that carbon, you will find there is a cup dug there. This high intensity carbon digs a cup out, and we have an energy density in there. We have about five or six colors radiating from each cubic centtimeter of gas. There are a lot of electrons falling apart in there, and the electron energy coming from the negative accounts for a great many subtle phenomena. The shell

of this is made of pure carbon. The voltage drop we used between flame material and the shell is of the order of 40 volts of the high amperage. Down here at ordinary voltage, it will be of the order of 20 volts. The result there is a 20-volt difference in drop, which will allow the current to be sucked down into that cup, and throw the energy density up very high, and that energy density in here is what I think causes the larger part of the high density effect, but the experts have not all agreed upon the phenomena that takes, and I don't think they are altogether agreed on the physics of the proposition.

Mr. Halvorson: It may be interesting to know that when you get up to much higher current densities, even with plain carbons, you get similar phenomena. At 750 amperes for instance, you get a very deep cratering with just plain carbon. During the war, as you may be aware, we did develop a 750 ampere arc in one unit for searchlight work. We used a 1⅛" diameter carbon, which worked well, but later increased it to two inches. I believe that the cause of deep cratering is that the center of the carbon gradually becomes more and more conductive until finally the whole current flows to the center of the electrode and that is where the highest intensity is obtained.

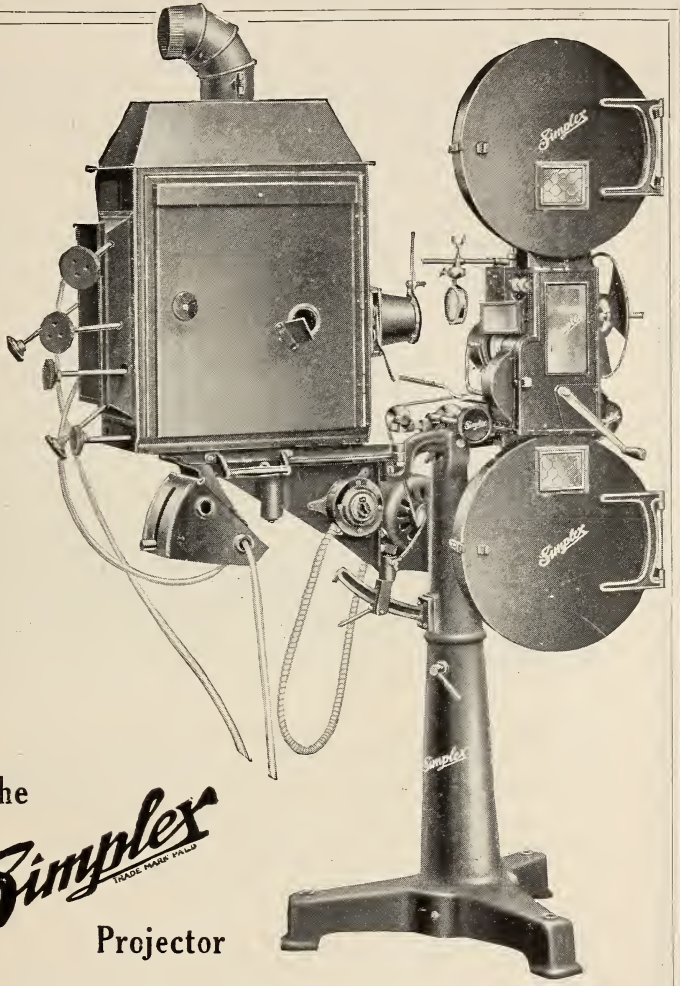
Mr. Bassett: Mr. Mott has answered the question completely. We have found that as the current is decreased it becomes increasingly more difficult to maintain the high intensity effect,, until we finally reach a point where by our present methods it is quite impractical to maintain this type of arc.

Dr. Mott: What I intended to do in bringing this little talk before you was to interest you people in setting up such an apparatus, any sort of apparatus, and actually put different chemicals in the arc, and see how many varieties of phenomena can be obtained, a variety of phenomena which will go far to getting at a great many secrets that are now concealed in nature.

Of course, in turn, there are any number of industrial applications of these things that have not been worked out that lie just around the corner, as you might say. There are a great many things that lie in the future of the development of the arc that have not been studied at all.

Several years ago I worked out an impregnated solid carbon that I could run at 2 to 4 amperes without slagging, and which gave an efficiency on direct current about four times that of the old type arc. You run into such a diversity of phenomena, such a wonderful field of experiments in all sorts of ways, that I want to encourage you, gentlemen, to play with the arc.

Advertising Section



The **Simplex** TRADE MARK REG. U.S. PAT. OFF.

Projector

"Used wherever perfect Projection is required"

THE PRECISION MACHINE CO. INC.

317 East 34th: St··· New York

MOTION PICTURE NEWS

FOUNDED :: 1908

Will be glad to supply any and all information on the Motion Picture Industry.

Reaches over 8,000 theatres each week. This is double the audited circulation of any other Trade Paper.

MOTION PICTURE NEWS Inc.

Main Office
729 Seventh Avenue
NEW YORK CITY

205 Baker-Derwiler Bldg.
LOS ANGELES

845 So. Wabash Ave.
CHICAGO

The Home of

Victor Picture Projectors

This entire manufacturing plant is devoted exclusively to the production of

Motion Picture Machines
Stereopticons and
Lantern Slides

Sixty thousand feet of floor space, plenty of fresh air and sunlight, precision machinery, the best of materials and contented expert workmen, combine in the making of the foremost line of non-theatrical picture projectors in America.

Catalogs and price lists mailed on application

VICTOR ANIMATOGRAPH CO., Inc.
Davenport, Iowa, U. S. A.

Sixty-five million feet of

EASTMAN FILM

was the average monthly production at Kodak Park last year, all manufactured on a *quality* basis.

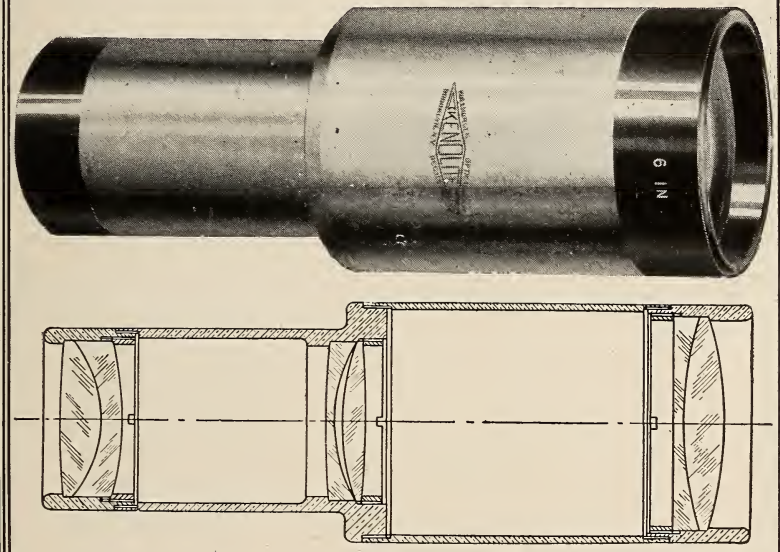
EASTMAN KODAK COMPANY
ROCHESTER, N. Y.

PERFECTION OF PROJECTION

Can only be obtained with the

KENOLITE

THREE COMBINATION LENS



32.8% More Light. 28% Better Definition. 10 Days Trial

Distributors of

POWERS PROJECTORS
SPEEDCO ARC CONTROLS
GENERAL ELECTRIC GENERATORS
IMSCO ENGINES and GENERATORS

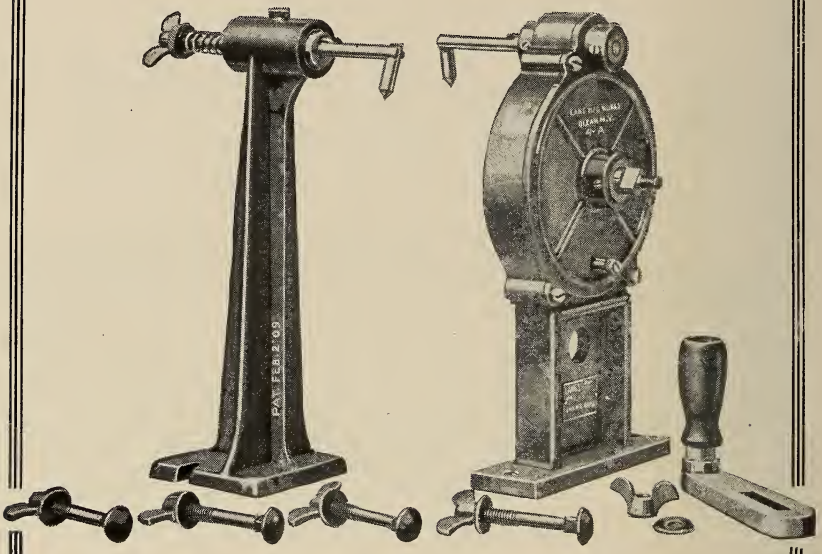
Independent Movie Supply Co., Inc.

W. H. RABELL, *Pres.*

729 Seventh Ave. SIXTH FLOOR New York

Our Catalogue Upon Request

LANG'S FILM REWINDER



Model 4-A

In Ordering New Projectors, etc. Specify

LANG-MADE
Rewinders and Reels

Adopted by U. S. Government

Made by

Lang Mfg. Works

The Rewinder and Reel People

OLEAN, NEW YORK, U. S. A.

Send for Circular

JOBBERS

United Projector & Film Co.
69-71 W. Mohawk St., Buffalo, N. Y.

J. Slipper & Company
728 Sou. Olive St., Los Angeles, Cal.

The Motor Generator That Produces Perfect Arcs.

Gives a steady arc, pure white light, two arcs in series and a perfect dissolve.

Arc amperage can be increased or decreased as desired.

Not affected by line variations.

Has self regulating voltage feature.

Quiet in operation, economical and reliable.

The A. C. to D. C. Transverter and Panel Board

The 110 to 230 Volt D.C. to D.C.

is a rotary transformer type of machine having an operating efficiency of 80% and higher.

Has arcs in series, constant current, self regulating voltage and all other operating advantages of the A.C. to D.C. Transverter.

Will effect a great saving for theaters having D.C. power circuit.

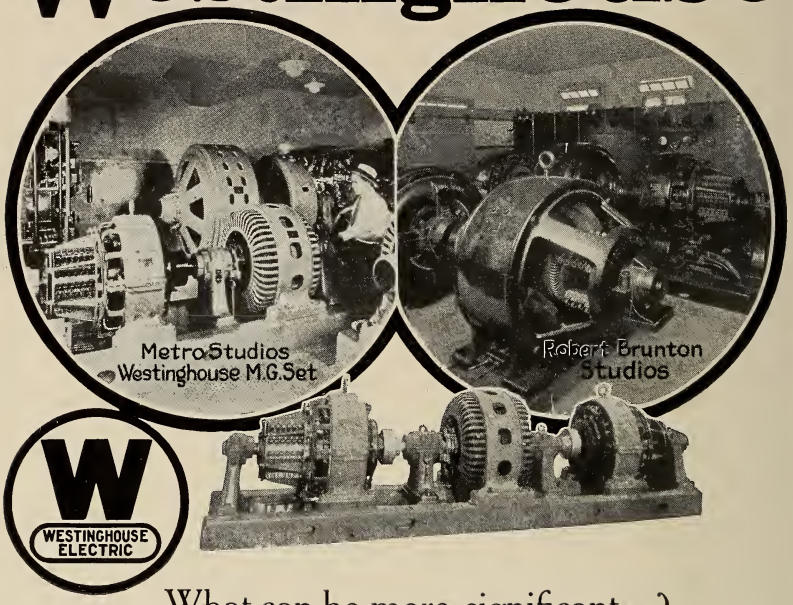
THE HERTNER ELECTRIC CO.
Cleveland, Ohio

Canadian Distributors
THE PERKINS ELECTRIC CO.

Phillips Square
MONTREAL

12 Temperance St.
TORONTO

Westinghouse



What can be more significant—?

The largest percentage of Electrical Apparatus used in the Motion Picture Industry is Westinghouse.

In the studio, or the theatre, Westinghouse equipment meets all requirements.

Westinghouse Elec. & Mfg. Co.
East Pittsburgh, Penna.

JUST OFF THE PRESS

"The Standard Authority on Motion Picture Projection"

MOTION PICTURE PROJECTION

By JAMES R. CAMERON

560 Pages Over 200 Illustrations

Shorn of All Technicalities Yet Complete and Comprehensive.

READ WHAT CRITICS SAY:

Exhibitors Trade Review—"Is by far the most complete and most interesting book yet published on that subject."

N. Y. Morning Telegraph—"Written with the amateur in mind as well as the professional—those using motion pictures in churches and schools will be especially interested.

Bureau of Economics Dept. of Public Instruction, Washington, D. C.—"By far the most complete manual we know of. The most comprehensive work of its kind."

Motion Picture News—"In comparison with all other works on the market this book is in a class by itself. Should be in the library of every projectionist. The price is not a criterion of its worth."

Wm. C. Francke, Asst. General Manager Simplex Machine Co.—Greatly impressed with book—far in excess of anything expected. Will do much to increase the life and efficiency of projection apparatus. Will be welcomed by progressive manufacturers, dealers and projectionists. Congratulate you on your achievement.

HUNDREDS OF OTHERS ON REQUEST

If you are interested in the motion picture business you need this book.

After comparative tests, Cameron's Hand Books were adopted by The American Red Cross, Y. M. C. A., Knights of Columbus and Community Motion Picture Bureau as the standard textbook on projection. It is being used by the U. S. Army and Navy authorities and most of the educational societies throughout the country.

$3.50 PRICE THREE FIFTY $3.50

Order from any Supply Dealer or direct from

THEATRE SUPPLY COMPANY

124 West 45th Street, New York City

M. J. WOHL, *President* MAX MAYER, *V.-Pres. & Treas.*

M. J. Wohl & Co., *Inc.*

Electrical Engineers

Specialists in artificial lighting for photographic processes.

Sole manufacturers and distributors of "BROAD-SIDE" and "DUPLEX" lamps used throughout the film industry.

"Wohlite" Lamps for Portable Work

New factory and general offices
Payntar Avenue and Hancock Street
Long Island City, New York

Columbia

COLUMBIA
Projector
Carbons

have made many a theater famous and profitable because of the beauty and eye comfort of its pictures

Write for information

NATIONAL CARBON COMPANY
Incorporated

Cleveland, Ohio San Francisco, Calif.

Canadian National Carbon Co., Limited. Toronto, Canada

A
Revolutionary Improvement

Power's—G. E. High Intensity Arc Lamp

Introduced As Part of
Power's Projectors
June, 1921

Descriptive and Operating Details Sent Upon Request.

NICHOLAS POWER COMPANY
INCORPORATED
EDWARD EARL, PRESIDENT
NINETY GOLD ST NEW YORK, N.Y

Synopsis of the Transactions

of the

Society of Motion Picture Engineers

From July 1916 to October 1920

With Indexes

By Subiects and By Authors

Synopsis of the Transactions of the Society of Motion Picture Engineers

No. 1—1916—Washington Meeting

Incorporation, Constitution and By-Laws.

Standardization—Henry D. Hubbard.

A discussion of standardization, what it is and how applied. Necessity to motion picture industry, standardization and future problems.

No. 2—October 2-3—1916—New York City

Chairman's Address—C. F. Jenkins.

An appeal for standardization.

Precision, The Dominant Factor in Motion Picture Machines—W. B. Westcott.

A survey of important standards. The reel spindle, camera lens, aperture, sprocket hole, precision, projection speed and their effect on the spectator.

Motion Picture Film Perforation—Donald J. Bell..

Historical—The intermittent sprocket is taken as a working basis. Film shrinkage and its relation to standard gauges and how the standard dimensions of film are obtained.

Condensers, Their Contour, Size, Location and Support—C. F. Jenkins.

Giving reasons for the use of condensers and the loss by reflection. Position of condensers, location of shutter, factors entering into location of elements of projection lens are given. The meniscus lens and condenser breakage is discussed.

No. 3—April 6-7—1917—Atlantic City

President's Address.

Establishment of Standards.

Motion Picture Cameras—Carl Louis Gregory.

An outline of the necessity of camera standardization, the frame line being the principle item.

Report of the Committee on Electrical Device—H. M. Wible, Chairman.

The advantages and disadvantages of Alternating Current and how objections may be overcome. Various methods of changing alternating current to direct current where alternating current is available and direct current is desired. Various apparatus for obtaining proper arc voltage when alternating current is to be used. Determination of proper arc voltage for both alternating and direct current at various currents. Relation of the frequency of alternating current and its synchronism with the shutter flicker. Nature size and structure of carbons required for both alternating current and direct current for various currents. Proper angle of carbons for alternating current and direct current. Maximum density of current at carbon points to obtain maximum efficiency.

Motion Picture Nomenclature.

Listing various terms used in the industry and defining them.

No. 4—July 16-17—1917—Chicago

President's Address.

An appeal for original development, standardization and fair play.

Report of the Committee on Optics—Herman Kellner.

Standardization of projection lenses, focal lengths, opening of lens support, aperture plate and maximum angle of projection.

Motion Picture Standards.

Standards adopted by the Society.

Motion Picture Nomenclature.

Listing various terms used in the industry and defining them.

No. 5—October 8-9—1917—New York City

President's Address.

Motion Picture Standards.

Standards adopted by the Society.

Motion Picture Nomenclature.

Listing various terms used in the industry and defining them.

Offset Projection—Will C. Smith.

Describing the effects of projection at an angle and illustrates these effects with drawings. Corrective suggestions are made.

Motion Picture Booth—C. Francis Jenkins.

A historical article followed by an appeal for greater safety in the projection room by the use of booths so placed and glassed in as to compel cleanliness and carefulness and therefore, safety.

Report of the Committee on Electrical Devices.

The characteristics and advantages of each form of apparatus used for converting alternating to direct current and the principles by which the selection of any apparatus may be made are stated together with complete wiring diagrams and operating charts.

The Projection of Motion Pictures by Means of Incandescent Lamps—
A. R. Dennington

Various filament arrangements and condenser systems are described, and the effect of the objective lens on the screen results is given. Screen results from various incandescent lamps are tabulated.

Light Intensities for Motion Picture Projection—J. T. Caldwell
R. P. Burrows

Certain factors of screens and their relation to a satisfactory picture are given, such as the importance of screen brightness, extraneous light and film density. Demonstration is made showing that an intensity of five foot candles is sufficient for good vision. A brief discussion of the relation between arc and incandescent lamp optical systems to screen brightness is given together with a bibliography on the subject.

No. 6—April 8-9—1918—Rochester

President's Address.

An appeal for greater safety.

Standardization of Exposure—John W. Allison.

The desire is to so standardize exposure as to obtain uniform density of film. An indirect system of lighting is described and an exposure meter was discussed which will give the results desired.

Optical Requirements of Motion Picture Projection Objectives—A. S. Corey.

This is a very technical discussion of the subject giving formulae used in determining the various factors entering into the design of projection objectives and shows the reason for these formulae.

Artificial Light in the Motion Picture Studio—Max Mayer.

This explains the nature of light sources, the color composition of light and the concentration of source; describes reflection surfaces and defusing screens. The arrangement of light sources is discussed together with the installation of the equipment and floor lamps. The distribution of current to the equipment is explained and the case of alternating current in the studio is treated.

Condensers—C. F. Jenkins.

A suggested type of condenser combining reflectors and a lens in order to utilize the maximum solid angle of light from an incandescent source.

The Portable Projector; Its Present Status and Needs—A. F. Victor.

A historical paper leading to a discussion of inflammable and non-inflammable film as used in portable projectors ending with an appeal to standardize a non-inflammable film for portable projectors.

Theoretical Vs. Practical As Applied to Standardization and Some of the Things to be Considered as Proper Subjects for Standardization—F. H. Richardson.

Suggesting some practical things to be considered in basing standards such as incompetent help, lack of knowledge, etc., and certain needed standards.

Incandescent Lamps for Motion Picture Service—A. R. Dennington.

The design of various types of incandescent sources is discussed, showing how an optical system utilizes a definite area of source. Specific data is given. The effect of the mirror on the lamp rating, temperature, and screen illumination is shown and the various types of condenser systems and objective lenses are discussed. The effect of the shutter is shown. A comparison of screen illumination between arc and incandescent lamps is given ending with a description of lamp house equipment and electric control equipment.

Some Consideration in the Application of Tungsten Filament Lamps to Motion Picture Projection—L. C. Porter and W. M. States.

A comprehensive study of the effects of improper setting of lamps and condensers to the screen results; profusely illustrated together with considerable practical data. Transmission of objectives is treated and the test apparatus used is described.

No. 7—November 18-20—1918—Cleveland, O.

President's Address.

Society's History.

Standardization of the Motion Picture Industry and the Ideal Studio—
J. W. Allison

This is a review of Mr. Allison's previous paper together with an outline of the suggested ideal studio and laboratory. Mr. Allison gives some consideration to the make-up of the artist. A discussion of this paper follows.

Motion Picture Film in the Making—Geo. A. Blair.

Mr. Blair describes the process of film manufacture, the elements entering into its composition, the care taken in keeping the film uniform and the inspections made during the manufacture and a check on the completed film for uniformity both photographically and physically. A discussion follows his paper.

The Carbon Arc for Motion Picture Projection—W. C. Kunzman.

Mr. Kunzman describes projection equipment and suggests proper carbon combinations for various current values and suggests proper carbon settings. He gives a brief outline of carbon manufacture and discusses the characteristics of direct and alternating current arcs, as regards the color of light, the reliability, flexibility and steadiness of the arc. A discussion follows this paper.

The Projection Room and Its Requirements—F. H. Richardson.

A brief history of the "booth" is given and followed by recommendations as to the details of structure such as dimensions, ventilation, sanitation, observation ports, position of room and safety equipment for the ideal booth. Mr. Richardson discusses the projectionist. This is an excellent paper for architects and exhibitors contemplating building.

Natural Color Cinematography—Wm. V. D. Kelly.

Mr. Kelly describes the methods of obtaining natural color film having a single emulsion, two emulsions on one side, a double coated emulsion and a single coated emulsion. The negative film, methods of coloring, the color filters, printing and production patents are discussed. The conclusion is a picture of what may be expected of color photography in the future.

The Function of the Condenser in the Projection Apparatus—Herman Kellner

This is an excellent theoretical discussion of the condenser and applicational results, giving absorption tables, diagrams and efficiency diagrams of various systems.

Sprocket Teeth and Film Perforations and Their Relation to Better Projection—A. C. Roebuck

Mr. Roebuck gives a general discussion of the subject followed by a description of a method for obtaining a generated sprocket tooth.

Fundamentals of Illumination in Motion Picture Projection—R. P. Burrows.

A simple explanation of the various fundamental units used in the measurement and determination of light intensities and how these units are applied in the industry.

Advantages in the Use of the New Standard Narrow Width Slow Burning Film for Portable Projection—W. B. Cook.

Mr. Cook discusses the history of this subject giving his idea of the solution of the problem and points out the economy and durability of this film in use.

No. 8—April 14-19—Philadelphia

President's Address.

White Light for Motion Picture Photography—Wm. Roy Mott.

Mr. Mott discusses the relation of light to the motion picture industry, pointing out the difference between theatre stage and motion picture stage lighting and covers the artistic relation of light together with the importance of high intensity of light. He shows the daily and yearly variation of daylight. In comparison to daylight, Mr. Mott discusses white light as obtained from flame arcs, under the headings of the spectrum of the white flame arc, the psychological effect of color, the relation to make-up, and film sensitiveness and gives data on the amount of light in relation to current and arc voltage. A description is given of several types of flame lamps together with a table of lamps and trims. The method of converting enclosed arcs to flame lamps is given and a description of the long life multiple trim arrangement. Various flame carbons such as the Star Core and Metal Coated Carbons are discussed and the general advantages of the white flame lamp for photography.

Some Phases of the Optical System of the Projector—F. H. Richardson.

A practical discussion of the action of the light rays beyond the condenser and a discussion with data to show the distribution of intensity of the light beam beyond the aperture and consequent loss of light. This paper is followed by a discussion by Dr. Kellner showing how the losses described can be avoided and also a discussion by Dr. Story on the same subject.

Condenser Design and Screen Illumination—H. P. Gage.

This illustrates the desirability of suitable design in order to obtain the proper balance between the different parts of the optical system to obtain maximum efficiency. A description is given of a simple and little used method of observing the operation of the optical system.

Adding Color to Motion—Wm. V. D. Kelly.

Mr. Kelly gives a history of colored pictures.

Attachments to Professional Cinematographic Cameras—Carl L. Gregory, F. R. P. S.—G. J. Badgley.

A discussion of many necessary and useful mechanical and optical attachments to the camera is given.

No. 9—October 13-15—1919—Pittsburgh

President's Address.

Preliminary Measurements of Illumination in Motion Picture Projection.—W. E. Story, Jr.

Dr. Story discusses a new method for measuring the illumination from optical systems by the use of a photo-electric cell and compares it to old methods. Some valuable data and curves are given showing variations in light delivered by various sizes of source, condensers and objectives.

Selection of Proper Power Equipment for the Modern Motion Picture Studio—H. F. O'Brien. H. A. Campe.

The authors cite most of the factors that must be considered in making the proper selection of power equipment in motion picture studios and suggests the type of equipment that should be selected to produce the best possible results under given conditions.

The Continuous Reduction Printer—Alexander F. Victor.

This is a description of a new type of printer to reduce from standard size negative to the safety standard positive.

Stereoscopic Motion Pictures—C. F. Jenkins.

This is a historical discussion of the subject.

No. 10—May 9-11—1920—Montreal

Motion Picture Standards.

Motion Picture Nomenclature.

Remote Control Switchboards for Studios—H. A. McNary.

Mr. McNary describes the remote control systems with a detailed description of one type of control box and push button station and discusses the operation of such a system.

Motion Pictures in Connection with Isolated Lighting Plants—R. L. Lee.

Mr. Lee discusses the difficulties in construction and describes the apparatus necessary, showing limitations for this class of projection.

Educational Possibilities of Motion Pictures—B. F. Norrish.

This is a popular paper on the subject.

Report of Committee on Progress—A. R. Dennington.

This is a progress report for the year in the art as relates to projection machines, carbons, incandescent lamps, electrical equipment and optical systems.

Tests of Screen Illumination From Motion Picture Projection—W. F. Little.

Mr. Little describes several test methods and analyzes the results obtained. He shows the changes in screen intensity with electrical values, lamp temperature and focusing.

Tinting of Motion Picture Film—G. A. Blair.

The methods of tinting are discussed together with the choice of dyes. The properties of acid dyes are given together with formula for tinting, preparation of the solution, nature, strength and temperature of the dye bath and some of the troubles encountered.

Heating and Ventilation of Motion Picture Theatres—O. K. Dyer.

This is an analysis of the requirements in heating and ventilating motion picture theatres and a discussion of methods used. The temperature and humidity of air and its effect on the audience is discussed. The subject of air washing is treated.

The Various Effects of Overspeeding Projection—F. H. Richardson.

Mr. Richardson discusses the effect of overspeeding projection as it effects the mechanism, film, picture, sprocket holes, the objects presented and the accompanying music.

The Eccentric Star Intermittent Movement—Willard B. Cook.

Mr. Cook describes this movement, compares it to other movements and outlines the advantages in the use of this particular type of intermittent.

Standards in Theatre Design to Safeguard From Fire and Panic—Wm. T. Braun.

This is an ideal code outline designed for maximum safety and is tabulated from the codes of large cities and the National Board of Fire Underwriters.

Interior Illumination of the Motion Picture Theatre—L. A. Jones.

This is a determination of the maximum value of general illumination allowable so as not to cause appreciable diminution of contrasts of projected picture. Theory, fundamentals and characteristics of the subject are given together with a description of an experimental installation and the results obtained from the experiment.

Continuous Motion Picture Machines—C. F. Jenkins.

A historical discussion of the subject and a discussion of some types of projectors.

Further Measurements of Illumination in Motion Picture Projection—
W. E.. Story, Jr.

The method previously described has been improved and applied to the measurement of the total illumination obtained on the screen with different source sizes and different condenser systems compared to the maximum obtainable with the given source brilliancy and given objective diameters. A comparison of the photoelectric measurements with the measurements obtained using an optical photometer for condensers of different absorption and sources of two slightly different brilliancies shows the ratio of the photoelectric cell readings to the photometer readings to be independent of color thru the range considered. Uniformity of screen illumination is also taken up in a general way by the application of direct observation of the screen to the automatically drawn curves registering total illumination.

Report of the Optic Committee.

The effect of color in a picture, on clearness, contrast, brightness, naturalness and mood.

No. 11—October 11-14—1920—Dayton

President's Address.

Extracts From Minutes of the Fifth Annual Meeting.

Report of the Committee on Progress.

Reporting progress for the year in the art as relates to projectors, a new arc lamp, arc control, camera motor, color studies and film exchange buildings.

History of the Motion Picture—C. F. Jenkins.

Mr. Jenkins discusses and illustrates the history of motion picture projection and early types of machines and methods.

Report of the Optics Committee.

A continuation of the discussion on the effect of color in projection and a tabulation of the results on brightness, clearness and contrasts for various film tints.

Reducing the Fire Hazards in Film Exchanges—Geo. A. Blair.

Mr. Blair tells how film burns and when explosions occur. He describes tests to determine methods of fire prevention and methods now used to reduce hazards.

Reflection Characteristics of Projection Screens—L. A. Jones.
Milton F. Fillius.

A very comprehensive paper on the subject describing methods and apparatus used in the test and materials examined. Results obtained are shown in graphic and tabular forms on 36 samples. These results are classified and a suggestion as to the selection of screens for maximum use is given.

Absorption and Reflection Losses in Motion Picture Objectives—Herman Kellner.

Dr. Kellner shows where the losses occur and the amount of these losses for various combinations of lenses.

The High Power Arc in Motion Pictures—Preston R. Bassett.

Mr. Bassett discusses the brilliancy of various sources of light and compares them. He shows an application of the new high intensity arc to searchlights and tells how results are obtained by increasing the brilliancy of the arc. The new projection lantern involving a new arc is described and test data in comparison with other arcs is given.

Design of Power Plant and Electrical Distribution in Large Studios—
J. R. Manheimer.

This paper contains many new ideas on the subject and describes fully power plants and the electric distribution, designed and installed in the studios and laboratories of the Famous Players-Lasky Corp., in Long Island City, N. Y., and the Fox Film Laboratory, New York City.

Portable Power Plants for Motion Picture Studios—H. F. O'Brien.

Several types of portable plants with engine driven equipments are discussed and the features of the design and equipment together with the necessary elements for portable plants is given.

INDEX BY AUTHORS

Transactions of Society of Motion Picture Engineers

From October, 1916 to October, 1920

AUTHOR	SUBJECT	DATE	Transac. Number	Page
Allison, J. W.	Standardization of Exposure	April 1918	6	
Allison, J. W.	Standardization of the Motion Picture Industry and the Ideal Studio	Nov. 1918	7	
Bassett, P. R.	The High Power Arc in Motion Pictures	Oct. 1920	11	
Bell, D. J.	Motion Picture Film Perforation	Oct. 1916	2	
Blair, G. A.	Motion Picture Film in the Making	Nov. 1918	7	
Blair, G. A.	Tinting of Motion Picture Film	May 1920	10	
Blair, G. A.	Reducing Fire Hazards in Film Exchanges	Oct. 1920	11	
Braun, Wm. T.	Standards in Theatre Design to Safeguard from Fire and Panic	May 1920	10	
Burrows, R. P.	Light Intensities for Motion Picture Projection	Oct. 1917	5	
Burrows, R. P.	Fundamentals of Illumination in Motion Picture Projection	Nov. 1918	7	
Cook, W. B.	Advantages in the Use of New Standard Narrow Width, Slow-Burning Film for Portable Projectors	Nov. 1918	7	
Cook, W. B.	The Eccentric Star Intermittent Movement	May 1920	10	
Corey, A. S.	Optical Requirements of Motion Picture Projection Objectives	April 1918	6	
Dennington, A. R.	Projection of Motion Pictures by Means of Incandescent Lamps	Oct. 1917	5	
Dennington, A. R.	Incandescent Lamps for Motion Picture Service	April 1918	6	
Dyer, O. K.	Heating & Ventilating Motion Picture	May 1920	10	
Gage, H. P.	Condenser Design & Screen Illumination	Nov. 1918	7	
Gregory, C. L.	Motion Picture Cameras	April 1917	3	
Gregory, C. L.	Attachments to Professional Cinematographic Cameras	April 1919	8	
Hubbard, H. D.	Standardization	1916	1	
Jenkins, C. F.	Stereoscopic Motion Pictures	Oct. 1919	9	
Jenkins, C. F.	Continuous Motion Picture Machines	May 1920	10	
Jenkins, C. F.	History of the Motion Picture	Oct. 1920	11	
Jenkins, C. F.	The Motion Picture Booth	Oct. 1917	5	
Jenkins, C. F.	Condensers, their Contour, Size, Location and Support	Oct. 1916	2	
Jenkins, C. F.	Condensers	April 1918	6	
Jones, L. A.	Reflection Characteristics of Projection Screens	Oct. 1920	11	
Jones, L. A.	The Interior Illumination of Motion Picture Theatres	May 1920	10	

AUTHOR	SUBJECT	DATE	Transac. Number Page
Kellner, H.	Absorption & Reflection Losses in Motion Picture Projection	Oct. 1920	11
Kellner, H.	The Function of the Condenser in the Projection Apparatus	Nov. 1918	7
Kelley, Wm. V. D.	Natural Color Cinematography	Nov. 1918	7
Kelley, Wm. V. D.	Adding Color to Motion	April 1919	8
Kunzmann, W. E.	Carbon Arcs for Motion Picture Projection	Nov. 1918	7
Lee, R. L.	Motion Pictures in Connection with Isolated Lighting Plants	May 1920	10
Little, W. F	Tests of Screen Illumination for Motion Picture Projection	May 1920	10
MacNary, H A.	Remote Control Switchboards for Motion Picture Studios	May 1920	10
Mannheimer, G. R.	Design of Power Plant and Electrical Distribution in Large Studios	Oct. 1920	11
Mayer, Max	Artificial Light in Motion Picture Studios	April 1918	6
Mott, W. R.	White Light for Motion Picture Photography	April 1919	8
Norrish, B. E.	Educational Possibilities of Motion Pictures	May 1920	10
O'Brien, H. F.	Selection of Proper Power Equipment for the Modern Motion Picture Studios	Oct. 1919	9
O'Brien, H. F.	Portable Power Plants for Motion Picture Studios	Oct. 1920	11
Porter, L. C.	Some Consideration in the Application of Tungsten Filament Lamps to Motion Picture Projection	April 1918	6
Richardson, F. H.	Theoretical vs Practical as Applied to Standardization and Some of the Things to be Considered as Proper Subjects for Standardization	April 1918	6
Richardson, F. H.	Some Phases of the Optical System of the Projector	Nov. 1918	7
Richardson, F. H.	The Various Effects of Over-Speeding Projection	May 1920	10
Richardson, F. H.	The Projection Room and its Requirements	Nov. 1918	7
Roebuck, A. C.	Sprocket Teeth and Film Perforations and Their Relationship to Better Projection	Nov. 1918	7
Smith, W. C.	Off-Set Projection	Oct. 1917	5
Storey, W. E.	Preliminary Measurements of Illumination in Motion Picture Projection	Oct. 1919	9
Storey, W. E.	Further Measurements of Illumination in Motion Picture Projection	Oct. 1919	9
Victor, A. F.	The Portable Projector—Its Present Status and Needs	April 1918	6
Victor, A. F.	The Continuous Reduction Printer	Oct. 1919	3
Westcott, W. B.	Precision, The Dominant Factor in Motion Picture Projection	Oct. 1916	2

INDEX BY SUBJECTS

Transactions of Society of Motion Picture Engineers

From October, 1916 to October, 1920

SUBJECT	AUTHOR	DATE	Transac. Number Page
Cameras			
Motion Picture Cameras	G. L. Gregory	April 1917	3
Attachments to Professional Cinematographic Cameras	G. L. Gregory & G. J. Badgley	April 1919	8
Carbon Arcs			
Carbon Arcs for Motion Picture Projection	W. E. Kunzmann	Nov. 1918	7
The High Power Arc in Motion Picture	P. R. Bassett	Oct. 1920	11
Condensers			
Condensers, Their Contour, Size, Location & Support	C. F. Jenkins	Oct. 1916	2
Condensers	C. F. Jenkins	April 1918	6
The Function of the Condenser in the Projection Apparatus	Herman Kellner	Nov. 1918	7
Condenser Design & Screen Illumination	H. P. Gage	Nov. 1918	7
Electrical Machinery			
Report of Committee on Electrical Devices		April 1917	3
Report of Committee on Electrical Devices		Oct. 1917	5
Film			
Motion Picture Film Perforation	D. J. Bell	Oct. 1916	2
Motion Picture Film in the Making	G. A. Blair	Nov. 1918	7
Tinting of Motion Picture Film	G. A. Blair	May 1920	10
Film, Safety Standard			
Advantages in the Use of New Standard, Narrow Wid h, Slow-Burning Film for Portable Projectors	W. B. Cook	Nov. 1918	7
The Portable Projector—Its Present Status and Needs	A. F. Victor	April 1918	6
The Continuous Reduction Printer	A. F. Victor	Oct. 1919	9
General			
Standardization	H. D. Hubbard	1916	1
Theoretical vs. Practical as Applied to Standardization and Some of the Things to be Considered as Proper Subjects for Standardization	F. H. Richardson	April 1918	6
Educational Possibilities of Motion Pictures	B. E. Norrish	May 1920	10
Reducing Fire Hazards in Film Exchanges	G. A. Blair	Oct. 1920	11
Historical			
Stereoscopic Motion Pictures	C. F. Jenkins	Oct. 1919	9
Continuous Motion Picture Machines	C. F. Jenkins	May 1920	10

SUBJECT	AUTHOR	DATE	Transac. Number Page
History of the Motion Picture	C. F. Jenkins	Oct. 1920	11
Incandescent Lamp Projection			
Projection of Motion Pictures by means of Incandescent Lamps	A. R. Dennington	Oct. 1917	5
Light Intensities for Motion Picture Projection	R. P. Burrows & J. T. Caldwell	Oct. 1917	5
Incandescent Lamps for Motion Picture Service	A. R. Dennington	April 1918	6
Some Consideration in the Application of Tungsten Filament Lamps to Motion Picture Projection	L. C. Porter & W. M. States	April 1918	6
Motion Pictures in Connection with Isolated Lighting Plants	R. L. Lee	May 1920	10
Light & Illumination			
Fundamentals of Illumination in Motion Picture Projection	R. P. Burrows	Nov.1918	7
Preliminary Measurements of Illumination in Motion Picture Projection	W. E. Storey	Oct. 1919	9
Tests of Screen Illumination for Motion Picture Projection	W. F. Little	May 1920	10
Further Measurements of Illumination in Motion Picture Projection	W. E. Storey	May 1920	10
Machine Design			
Sprocket Teeth and Film Perforations and Their Relationship to Better Projection	A. C. Roebuck	Nov. 1918	7
The Eccentric Star Intermittent Movement	W. B. Cook	May 1920	10
Motion Picture Booth			
The Motion Picture Booth	C. F. Jenkins	Oct. 1917	5
The Projection Room and Its Requirements	F. H. Richardson	Nov. 1918	7
Natural Color Photography			
Natural Color Cinematography	Wm. V. D. Kelley	Nov. 1918	7
Adding Color to Motion	Wm. V. D. Kelley	April 1919	8
Objectives			
Optical Requirements of Motion Picture Projection Objectives	A. S. Corey	April 1918	6
Absorption & Reflection Losses in Motion Picture Projection	H. Kellner	Oct. 1920	11
Optics			
Some Phases of the Optical System of the Projector	F. H. Richardson	Nov. 1918	7
Report of Committee on Optics		July 1917	4
Report of Committee on Optics		May 1920	10
Report of Committee on Optics		Oct. 1920	11
Photography			
Standardization of Exposure	J. W. Allison	April 1918	6
White Light for Motion Picture Photography	W. R. Mott	April 1919	8

SUBJECT	AUTHOR	DATE	Transac. Number Page
Projection			
Precision, The Dominant Factor in Motion Picture Projection	W. B. Wescott	Oct. 1916	2
Off-Set Projection	W. C. Smith	Oct. 1917	5
The Various Effects of Over-Speeding Projection	F. H. Richardson	May 1920	10
Standards—Nomenclature			
Motion Picture Standards		Oct. 1917	5
Motion Picture Nomenclature		Oct. 1917	5
Motion Picture Standards		July 1917	4
Motion Picture Nomenclature		July 1917	4
Motion Picture Nomenclature		April 1917	3
Studios			
Artificia Light in Motion Picture Studios	Max Mayer	April 1918	6
Standardization of the Motion Picture Industry and the Ideal Studios	J. W. Allison	Nov. 1918	7
Selection of Proper Power Equipment for the Modern Motion Picture Studios	H. A. Campe & H. F. O'Brien	Oct. 1919	9
Remote Control Switchboards for Motion Picture Studios	H. A. MacNary	May 1920	10
Design of Power Plant and Electrical Distribution in Large Studios	G. R. Mannheimer	Oct. 1920	11
Portable Power Plants for Motion Picture Studios	H. F. O'Brien	Oct. 1920	11
Screens			
Reflection Characteristics of Projection Screens	L. A. Jones	Oct. 1920	11
Theatre Design and Equipment			
Heating and Ventilating Motion Picture Theatres	O. K. Dyer	May 1920	10
The Interior Illumination of Motion Picture Theatres	L. A. Jones	May 1920	10
Standards in Theatre Design to Safeguard from Fire and Panic	Wm. T. Braun	May 1920	10

PRICE LIST OF TRANSACTIONS OF THE S. M. P. E.

No. 1	Out of Print
No. 2	25c
No. 3	25c
No. 4	25c
No. 5	25c
No. 6	25c
No. 7	25c
No. 8	25c
No. 9	$1.00
No. 10	$1.00
No. 11	$1.00

Orders for Transactions and requests for information should be sent to

A. F. VICTOR, *Secretary*,
Society of Motion Picture Engineers,
50 West 67th Street, New York City.

460 98

HECKMAN
BINDERY INC.
1992
N. MANCHESTER,
INDIANA 46962

LIBRARY OF CONGRESS
0 013 660 649 9